# Office of Technology Assessment

## Congressional Board of the 98th Congress

MORRIS K. UDALL, *Arizona, Chairman*

TED STEVENS, *Alaska, Vice Chairman*

### Senate

ORRIN G. HATCH
*Utah*

CHARLES McC. MATHIAS, JR.
*Maryland*

EDWARD M. KENNEDY
*Massachusetts*

ERNEST F. HOLLINGS
*South Carolina*

CLAIBORNE PELL
*Rhode Island*

### House

GEORGE E. BROWN, JR.
*California*

JOHN D. DINGELL
*Michigan*

LARRY WINN, JR.
*Kansas*

CLARENCE E. MILLER
*Ohio*

COOPER EVANS
*Iowa*

JOHN H. GIBBONS
*(Nonvoting)*

## Advisory Council

CHARLES N. KIMBALL, *Chairman*
*Midwest Research Institute*

EARL BEISTLINE
*University of Alaska*

CHARLES A. BOWSHER
*General Accounting Office*

CLAIRE T. DEDRICK
*California Land Commission*

JAMES C. FLETCHER
*University of Pittsburgh*

S. DAVID FREEMAN
*Tennessee Valley Authority*

GILBERT GUDE
*Congressional Research Service*

CARL N. HODGES
*University of Arizona*

RACHEL McCULLOCH
*University of Wisconsin*

WILLIAM J. PERRY
*Hambrecht & Quist*

DAVID S. POTTER
*General Motors Corp.*

LEWIS THOMAS
*Memorial Sloan-Kettering Cancer Center*

## Director

JOHN H. GIBBONS

The Technology Assessment Board approves the release of this report. The views expressed in this report are not necessarily those of the Board, OTA Advisory Council, or of individual members thereof.

# WETLANDS THEIR USE AND REGULATION

**OTA Reports** are the principal documentation of formal assessment projects. These projects are approved in advance by the Technology Assessment Board. At the conclusion of a project, the Board has the opportunity to review the report, but its release does not necessarily imply endorsement of the results by the Board or its individual members.

CONGRESS OF THE UNITED STATES
**Office of Technology Assessment**
Washington, D.C. 20510

J952-15

Recommended Citation:

*Wetlands: Their Use and Regulation* (Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-O-206, March 1984).

Library of Congress Catalog Card Number 84-601014

For sale by the Superintendent of Documents
U.S. Government Printing Office, Washington, D.C. 20402

# Foreword

This report presents the findings and conclusions of OTA's analysis of approaches to wetlands use. Historically, wetlands were considered wastelands and conversion to other uses was actively encouraged. Two trends in recent decades, however, have altered this perception. First, there has been a growing appreciation for the esthetic and recreational qualities of wetlands; and second, there is now a general recognition of the hydrological and ecological services that wetlands provide. In spite of this increased awareness of the esthetic, recreational, and ecological values of wetlands, pressure to convert wetlands to cropland, commercial development sites, and other uses is still significant in certain regions of the country. This presents a conflict between those who want to convert wetlands to other uses and those who feel they should be left in their natural state.

Section 404 of the Federal Water Pollution Control Act (1972), now referred to as the Clean Water Act, authorizes the U.S. Army Corps of Engineers (Corps) to regulate the disposal of dredged or fill material into "the waters of the United States," which includes many wetlands. Because this act opened the way for Federal regulation of many development activities that occur in wetlands, the 404 program has been the center of considerable controversy. Federal regulation of privately owned wetlands through 404 is viewed by some as land-use control, traditionally the legal domain of State and local governments. Others, who view wetlands as a national water resource, argue that the Federal Government has an obligation to protect those wetlands that are important to the public.

OTA undertook this study at the request of the Senate Committee on Environment and Public Works and its Subcommittee on Environmental Pollution. It describes the ecological values of wetlands, trends in wetlands use, and the effect of Federal and State wetland programs on wetlands. In addition, OTA reviewed the existing scientific literature to provide background information on the ecological services provided by wetlands. Although this report deals broadly with wetlands and their use, many of its findings relate directly to the Corps' 404 program, which is the major avenue for Federal involvement in regulating some activities that use wetlands. Furthermore, because agricultural drainage and clearing have been responsible for the vast majority of wetland conversions since the mid-1950's, OTA examined in some detail the policies that encourage the conversion of wetlands to agricultural uses.

The data available to resolve these issues proved scanty and of highly mixed quality. For example, good data on wetland trends is only available for the 20-year period **prior** to implementation of the 404 program. Thus, generalizations about the values of wetlands or the effects of Federal programs, while valid to broad policymaking, are often misleading if applied to site-specific situations. However, within the limitations of this uncertainty, this OTA report provides a policy perspective that could lead to more coherent and rational policies for managing the competing uses of wetlands.

OTA is grateful for the support, assistance, and cooperation received in this assessment from many people representing a great diversity of viewpoints on wetland issues.

John H. Gibbons

JOHN H. GIBBONS
*Director*

# Wetlands Advisory Panel

William H. Patrick, Jr., *Chairman*
Director, Laboratory for Wetland Soils and Sediment, Louisiana State University

Hope M. Babcock
National Audubon Society

Earl H. Beistline
Dean, School of Mineral Industry
University of Alaska

Charles E. Fraser
President
Sea Pines Co.

Donald W. Gilman
Alaska State Senator

Laurence R. Jahn
Vice President
Wildlife Management Institute

Joseph S. Larson
Chairman, Department of Forestry and Wildlife Management
University of Massachusetts

Stanley L. Lattin
Director of Planning and Economic Development
Port of Grays Harbor

Jay A. Leitch
Department of Agricultural Economics
North Dakota State University

Ralph Manna, Jr.
Division of Regulatory Affairs
New York Department of Environmental Conservation

William Manning
Louisiana Land & Exploration Co.

Eric Metz
California Coastal Commission

Mark Rey
National Forest Products Association

Laurence Simns
President
Maryland Waterman's Association

Hobart G. Truesdell, II
President
First Colony Farms

Daniel E. Willard
School of Public and Environmental Affairs
Indiana University

# OTA Project Staff—Wetlands Assessment

John Andelin, *Assistant Director, OTA*
*Science, Information. and Natural Resources Division*

Robert Niblock, *Oceans and Environment Program Manager*

William Barnard, *Project Director*

Joan Harn, *Analyst* Daniel Kevin, *Analyst*

Christopher Ansell, *Research Analyst*

**Administrative Staff**

Kathleen Beil Jacquelynne Mulder Kay Senn

**Principal Contractors and Other Contributors**

Center for Environmental Studies, North Dakota State University
Center for Governmental Responsibility, University of Florida
Center for Great Plains Studies, University of Nebraska
Center for Wetland Resources, Louisiana State University
John R. Clark
Ken Cook
William E. Davis*
ESA/Madrone
Warren E. Frayer
JACA Corp.
Jon A. Kusler
Orie L. Loucks
National Wetlands Technical Council, Environmental Law Institute
R. Wayne Nelson & Associates
School of Forestry and Environmental Studies, Duke University
Leonard Shabman
Shapiro & Associates, Inc.
Water Resources Research Center, University of Massachusetts
Kathryn M. White, Writer/Editor

## OTA Publishing Staff

John C. Holmes, *Publishing Officer*

John Bergling Kathie S. Boss Debra M. Datcher Joe Henson

Glenda Lawing Linda A. Leahy Cheryl J. Manning

---

*OTA staff.

# Contents

*Chapter* *Page*

1. Summary . . . 3

2. Wetland Types . . . 25

3. Wetland Values and the Importance of Wetlands to Man . . . 37

4. Wetland Programs That Affect the Use of Wetlands . . . 69

5. Wetland Trends . . . 87

6. Impacts and Mitigation . . . 117

7. The Effects of the 404 Program . . . 141

8. Limitations of the 404 Program for Protecting Wetlands . . . 167

9. Capabilities of the States in Managing the Use of Wetlands . . . 187

Appendix—List of Acronyms and Glossary . . . 199

Index . . . 205

# Chapter 1
# Summary

Photo credit: U.S. Fish and Wildlife Service—L. Childers

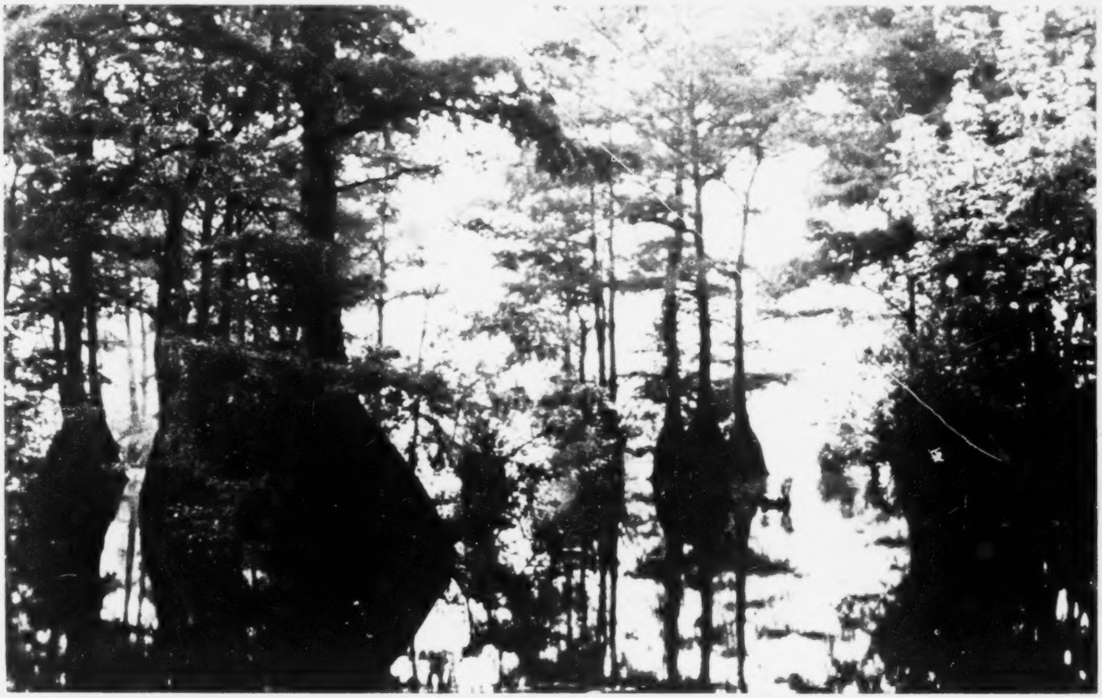


Photo credit: U.S. Fish and Wildlife Service—E. Laverne Smith

# Contents

*Page*

**Introduction** 3

**Values and Uses of Wetlands** 5

The Intrinsic Qualities and Ecological Services Associated With Wetlands 5

Wetland Conversions 5

Trends in Wetland Use 6

**Programs and Policies Affecting Wetland Use** 7

Federal Programs Discouraging Wetland Conversions 10

Federal Programs Encouraging Wetland Conversions 12

Administration Policies 13

State Wetland Programs 13

Local Wetland Programs 13

Private Initiatives 13

**Policy Considerations and Options** 13

Policy Considerations 13

Policy Issues 14

Policy Options 14

## TABLES

*Table No.* *Page*

1. Wetland Conversions From Mid-1950's to Mid-1970's 7
2. Major Federal Programs Affecting the Use of Wetlands 9

## FIGURES

*Figure No.* *Page*

A. Actual Wetland Conversions 8

B. 404 Permit Statistics, 1981 12

# Chapter 1
# Summary

## INTRODUCTION

The use of wetlands—the marshes, swamps, bogs, bottom lands, and tundra that comprise about 5 percent of the contiguous United States and about 60 percent of Alaska—is a source of controversy between those who want to convert these areas to other uses and those who want them left in their natural state. Some wetlands can provide natural ecological services such as floodwater storage, erosion control, improved water quality, habitat for fish and wildlife, and food chain support. In addition, many wetlands are esthetically pleasing and offer varied recreational and educational opportunities. At the same time, these wetlands may provide sites for housing, agriculture, or commercial development.

Wetlands are usually characterized by emergent plants growing in soils that are periodically or normally saturated with water.* They occur along gradually sloping areas between uplands and deepwater environments, such as rivers, or form in basins that are isolated from larger water bodies. Of the 90 million acres of vegetated wetlands in the lower 48 States, 95 percent are located in inland, freshwater areas; the rest are coastal, saltwater wetlands. In addition, it is estimated that nearly 60 percent of the State of Alaska—or over 200 million acres—is covered by wetlands.

Within the last 200 years, 30 to 50 percent of the wetlands in the lower 48 States have been converted to other uses by activities such as agriculture, mining, forestry, oil and gas extraction, and urbanization. According to the most recent Federal survey, a net amount of approximately 11 million acres of wetlands in the lower 48 States were converted to such other uses between the mid-1950's and mid-1970's.* **This amount was equivalent to a net loss each year of about 550,000 acres, or about 0.5 percent of remaining wetlands. The vast majority of actual losses—about 80 percent—involved draining and clearing of inland wetlands for agricultural purposes.** Although some wetland losses were due to natural causes such as erosion, sedimentation, subsidence, and sea level rise, **at least 95 percent of actual wetland losses over the last 25 years were due to man's activities.** The best available information indicates that present national wetland-conversion rates are about half of those measured in the 1950's and 1960's or about 300,000 acres per year. This reduction is due primarily to declining rates of agricultural drainage, and secondarily to government programs that regulate wetlands use.

At this time, **Federal policies and programs do not deal consistently with wetlands use. In fact, they affect wetland use in opposing ways.** Some policies encourage conversions: tax deductions and credits can significantly reduce wetland conversion costs for farmers. On the other hand, regulatory and acquisition programs discourage conversions. **The U.S. Army Corps of Engineers' regulatory program established by section 404 of the Clean Water Act, provides the major avenue of Federal involvement in controlling the use of wetlands by regulating discharges of dredged or fill material into wetlands.**

For those activities that come under regulation by the Corps, annual conversions are reduced nationwide by about 50 percent, or 50,000 acres of wetlands per year, primarily through project modifications. Because most activities that occur in coastal wetlands are regulated by the Corps and/or State wetland programs, **coastal wetlands are reasonably well protected.** However, many activities, such as excavation and traditional clearing and drainage for farming and other uses, are not regulated by either the Corps or by most State wetland programs. These activities were responsible for the vast majority of past conversions, especially in inland areas, where 95 percent of the Nation's wetlands are located. **Inland, freshwater wetlands are generally poorly protected.**

---

*The Fish and Wildlife Service (FWS) used the term "wetland" in 1952 to describe a number of diverse environments that shared characteristics of both aquatic and terrestrial habitats—i.e., lands at least temporarily inundated, but with "emergent" vegetation adapted to saturated soil conditions. Presently, there are two major Federal definitions. One definition was established by FWS for purposes of mapping and classification of wetlands; the second, more restrictive, definition was developed by the U.S Army Corps of Engineers and the Environmental Protection Agency for the purpose of regulation. As a result, FWS has estimated that in the mid-1970's there were 99 million acres of vegetated and nonvegetated wetlands in the lower 48 States. In comparison, the Corps estimates that its jurisdiction extends over approximately 64 million acres of wetlands. The differences in the interpretation of what constitutes a wetland have led to considerable confusion and a great deal of controversy. Disagreement exists, for example, over whether parts of the Alaskan tundra and drier sections of bottom land hardwoods should be considered wetlands.

*The analyses presented in this study apply only to vegetated wetlands. If unvegetated habitats, such as mud flats, were included, the quantitative estimates describing wetland trends could change by as much as 10 to 20 percent. However, the overall wetland trends in the lower 48 States and the policy options discussed later are not significantly affected by differences in wetland definitions.

The current rates of wetland loss are not likely to have catastrophic enviromental impacts in the next few years, but the continued incremental conversion of wetlands, especially in certain inland regions of the country, could have significant adverse ecological effects over the next few decades. To address this situation, the Federal Government could play an important role in integrating ongoing efforts to manage the Nation's wetlands.

Over the next decade existing wetland programs can be integrated in a few successive steps. First, the Federal Government could complete its ongoing mapping of wetlands; high priority could be assigned to those areas where development pressures are high. Next, the wetlands in different regions of the country could be categorized according to their relative values. This would enable existing wetland programs to be tailored in a consistent and integrated manner to the broad categories of wetlands and to prospective development activities. If deemed necessary, the Government could broaden the scope of different wetland programs (e.g., regulation, acquisition, leasing, etc.) to include the full range of wetland values, rather than continuing to focus on individual values, such as wildlife habitat. By taking these steps, higher value wetlands would receive more protection than wetlands of lower value. Developers also would have prior knowledge about standards and requirements for converting specific wetland areas, thus simplifying the regulatory process.

For such an integrated approach to wetlands management, further efforts also would be needed to reduce uncertainties about: recent wetland trends, the ecological significance of additional wetland conversions, and the effect of major policies and programs on wetlands use. A detailed work plan developed by an interagency working group would help to ensure that all required activities are accomplished in a timely manner.

Finally, while this plan is being developed, Congress may wish to provide additional protection for wetlands, especially higher value wetlands that may be subject to agricultural conversion. This could be done through acquisition or easements from the Department of the Interior's Fish and Wildlife Service, or through leases from the Department of Agriculture's (USDA) Water Bank Program. All of these options can provide comparable levels of protection. For a given level of funding, many more wetlands can be protected with leases than with easements or acquisition; however, leases only provide short-term protection.

During the course of this study, data were collected from the scientific literature, Government reports, and responses to questionnaires about wetlands use from 37 out of 38 Corps districts, from 48 States, and from 11 out of 20 trade associations surveyed. The Office of Technology Assessment (OTA) also conducted case studies of wetland trends in 13 States and minor studies in 8 States,* and interviewed many Federal and State personnel and industry representatives. Because agricultural activities were responsible for the vast majority of past wetland conversions, agricultural policies were surveyed in somewhat greater detail than were most other Federal policies.

As a result of its studies, OTA has identified three issues related to wetlands management. First, should Federal involvement in protecting wetlands be increased or decreased? Second, should the Federal Government improve its policymaking capability through a systematic collection and analysis of additional information about wetlands? Finally, should the Federal Government develop a more integrated approach for managing the use of wetlands? More detailed analyses of the technical and institutional information that relates to these policy options are presented in later chapters of this report.

---

*Case studies were conducted for Alaska, California, Florida, Louisiana, Massachusetts, Minnesota, Nebraska, New Jersey, North Carolina, North Dakota, Rhode Island, South Carolina, and Washington. Minor studies were conducted in Connecticut, Maine, Maryland, Mississippi, New Hampshire, South Dakota, Texas, and Vermont.

· The results of the study are presented in this summary in three sections: values and uses of wetlands, programs and policies affecting wetland use, and policy considerations and options.

# VALUES AND USES OF WETLANDS

## *The Intrinsic Qualities and Ecological Services Associated With Wetlands*

Some people value wetlands for their **intrinsic qualities.** Their primary motivation for protecting wetlands is simply a desire to preserve natural areas for future generations, or because they are often the last areas to be developed. Others value the varied and abundant flora and fauna found in wetlands and the opportunities for hunting, fishing, boating, and other recreational activities. While recreational benefits can be quantified to some extent, the other intrinsic values of wetlands are, for the most part, intangible. For this reason, the justification for protecting wetlands has often focused on the importance of the **ecological services** or resource values that wetlands provide, which are more scientifically and economically demonstrable than intrinsic qualities (box A).

The intrinsic qualities and ecological services provided by wetlands can vary significantly from one wetland to another and from one region of the country to another. For example, mangrove swamps, while only of marginal importance to waterfowl, are very important for erosion control along the Florida coast. Some wetlands provide benefits that are primarily local or regional in nature; other benefits may be national or even international in scope. **Because of the many differences between individual wetlands, the significance of their ecological services and intrinsic qualities must be determined on an individual or regional basis.**

In making such a determination, the dollar value of the ecological services that wetlands provide can sometimes be quantified. The Corps, for instance, estimated that the loss of the entire 8,422 acres of wetlands within the Charles River Basin in Massachusetts would result in average annual flood damages of over $17 million. However, because the many intrinsic qualities of wetlands cannot be quantified, it is usually difficult to place generally accepted dollar values on wetlands.

## *Wetland Conversions*

Wetlands can provide important sites for development activities such as agriculture, forestry, port and harbor development, oil and gas extraction, housing and urban growth, mining, and water resource development. Wetland drainage for agricultural purposes is particularly widespread in the Lower Mississippi River Valley and in some areas of the Southeast. Some activities, such as peat mining and cranberry production, can take place only in wetlands or in former wetlands; other activities may achieve cost savings by using wetlands rather than upland areas. Some wetlands lie over natural resources such as oil, gas, and phosphate ore deposits. For example, unprocessed phosphate ore underlying wetlands in coastal areas of North Carolina may be worth several hundred thousand dollars per acre. **Although development activities that affect wetlands are probably worth billions of dollars annually, data were not available for OTA to estimate the total net monetary values of these activities as they relate to wetlands.**

**Development activities that involve excavation (or dredging), filling, clearing, draining, or flooding of wetlands generally have the most significant and permanent impacts on wetlands and the ecological services they provide.** The extent of these impacts varies among projects, depending on the scale and timing of the project, the type of wetland affected, and many other variables. In many cases, project impacts can be reduced by redesigning the project or by modifying construction timetables.

The ability to restore significantly degraded wetlands or converted areas to their original condition depends on the type of wetland and on the degree to which it has been affected by natural processes or by particular development activities. For example, former San Francisco Bay wetlands that were formerly used for agriculture are now being restored by removing manmade dikes that once separated them from the Bay. It is also possible to create new

### Box A.—Ecological Services of Wetlands

**Floodpeak Reduction.**—Isolated and flood plain wetlands may temporarily store runoff, and flood plain wetlands may slow the downstream flow of water and provide additional capacity for conveying floodwaters, thus reducing floodpeaks and the frequency of flooding in downstream areas. For example, the swampland in the Cache River watershed in southern Illinois retains about 8.4 percent of the watershed's total runoff during flooding.

**Water-Quality Improvement.**—By temporarily or permanently retaining pollutants, such as suspended material, excess nutrients, toxic chemicals, and disease-causing micro-organisms, wetlands can improve, to varying degrees, the quality of the water that flows over and through them. Some pollutants that are trapped in wetlands may be converted by biochemical processes to less harmful forms. Some pollutants may remain buried; others may be taken up by wetland plants and either recycled within the wetland or transported from it. By temporarily delaying the release of nutrients until the fall, wetlands may help prevent excessive algal growth in open-water areas in the spring, when nutrient availability from other sources is typically high. Wetlands can retain nutrients on a net annual basis and have been used successfully for secondary treatment of sewage effluents.

**Food and Habitat.**—Wetlands provide food and habitat for many game and non-game animals. For some species, wetlands are essential for survival. For instance, many species of waterfowl and freshwater and saltwater fish require wetlands for breeding and nesting. Approximately 20 percent of all plant and animal species listed by the Federal Government as threatened or endangered depend heavily on wetlands. For other species, wetlands serve more general needs. Coastal marshes and certain types of inland, freshwater wetlands achieve some of the highest rates of plant productivity of any natural ecosystem. This high productivity often supports varied and abundant animal populations within a complex food chain. During the growing season, less than 15 percent of the plant biomass in saltwater marshes is consumed directly by foraging animals. After the plants die, up to 70 percent of the plant material is broken down into small particles and flushed into adjacent waters, where it becomes a potential food source for estuarine-dependent fish and shellfish.

**Shoreline Stabilization.**—Some vegetated saltwater and freshwater wetlands significantly reduce shoreline erosion caused by large waves and major coastal and riverine flooding. For example, in a comparative study, an unvegetated shoreline retreated at a rate of more than twice that observed for a similar shoreline fringed by a marsh.

**Ground Water Recharge.**—Some wetlands that are hydrologically connected to a ground water system supplement local or regional ground water supplies through infiltration/percolation of surface water. However, the potential for most wetlands to recharge ground water is limited. In general, uplands are more effective recharge areas than wetlands.

wetlands in areas that are not subject to a high degree of wave action or swift currents. Most experience at creating new wetlands has been in relatively calm coastal environments, where costs range from as little as $250 to over $6,000 per acre.

**The ability to construct new wetlands or to restore converted ones should not be used as sole justification for converting wetlands to other uses:** manmade wetlands do not necessarily provide the same values as natural ones. In addition, it is probably not possible to create new wetlands or to restore them at the rate they have been converted to other uses in the past.

## *Trends in Wetland Use*

**Wetland conversion rates, which averaged about 550,000 acres per year for the Nation between the mid-1950's and mid-1970's, vary significantly throughout the country.** On the one hand, conversion rates in the Lower Mississippi River Valley were nearly three times the national average; on the other hand, wetland conversions occurred in coastal areas at rates that were about 25 percent less than inland conversion rates (table 1).

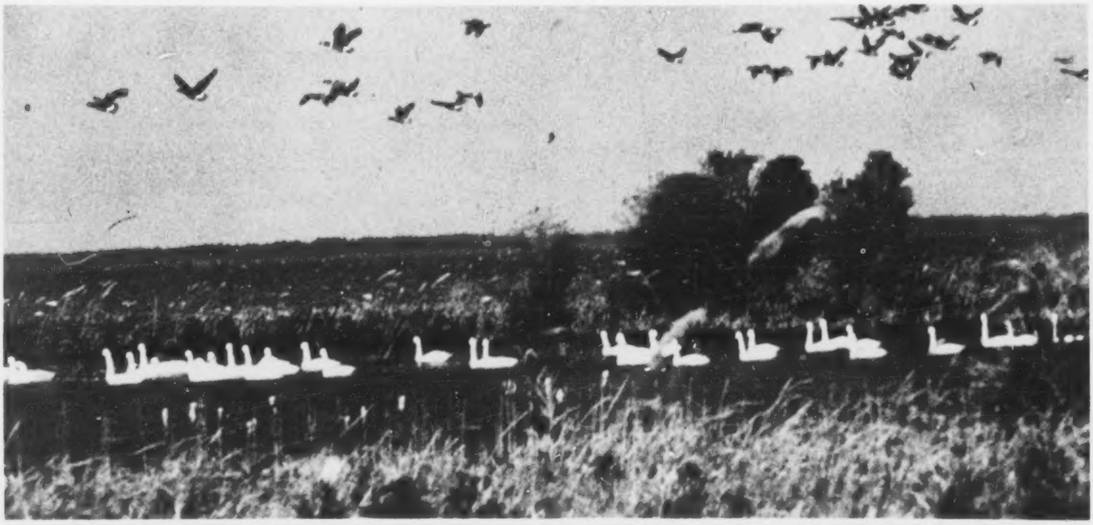


Photo credit: U.S. Fish and Wildlife Service

Wetlands provide food and habitat for many species of fish and wildlife. Waterfowl, in particular, often require wetland habitats for breeding and nesting.

**Table 1.—Wetland Conversions From Mid-1950's to Mid-1970's**

| | Original acreage mid-1950's (million acres) | Net loss[a] | |
|---|---|---|---|
| | | Million acres | Conversion rate |
| Coastal . . . | 4.8 | 0.4 | 8.3% |
| Inland . . . . | 100.0 | 11.0 | 11.0% |

[a] Net losses are calculated by subtracting the gains in wetlands (from man-induced and natural causes) from the actual losses of wetlands.

SOURCE: Original data from FWS National Wetland Trends Study, 1983.

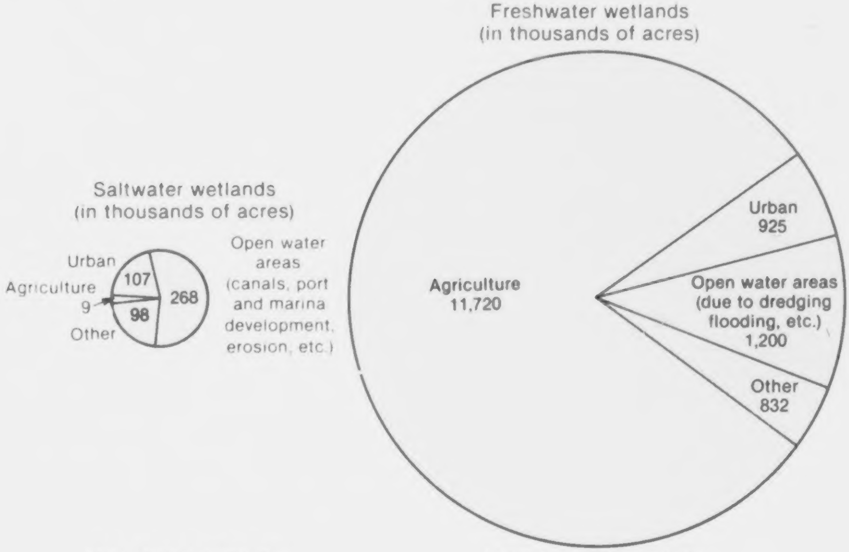
**Ninety-seven percent** of actual wetland losses (or conversions from wetland to nonwetland areas) occurred in **inland,** freshwater areas during this 20-year period (fig. A). Agricultural conversions involving drainage, clearing, land leveling, ground water pumping, and surface water diversion were responsible for 80 percent of these conversions. Of the remainder, 8 percent resulted from the construction of impoundments and large reservoirs, 6 percent from urbanization, and 6 percent from other causes, such as mining, forestry, and road construction. Fifty-three percent of these conversions occurred in forested areas, such as bottom lands. Of the actual losses of **coastal** wetlands, approximately 56 percent resulted from dredging for marinas, canals, and port development, and to a lesser extent from shoreline erosion; 22 percent resulted from urbanization; 14 percent from disposing of dredged material or from creating beaches; 6 percent from natural or man-induced transition of saltwater wetlands to freshwater wetlands; and 2 percent from agriculture.

Wetland conversions have adversely impacted the environment in some regions of the country. For example, reductions in Pacific-flyway migratory waterfowl have been directly correlated to the conversion of about 90 percent of California's wetlands. While the ecological significance for the Nation of wetland conversions over the last several decades is uncertain, the environment will undoubtedly be negatively affected if conversions continue.

## PROGRAMS AND POLICIES AFFECTING WETLAND USE

Wetland use is directly and indirectly affected by a variety of Federal (table 2), State, local, and private programs that were developed, for the most part, during the past two decades. These programs affect wetland use through regulation, acquisition, leasing, easements, and general policy guidance.

**Figure A.—Actual Wetland Conversions** (mid-1950's to mid-1970's)



Total saltwater wetland
loss (actual): 482,000 acres

Total freshwater wetland
loss (actual): 14,677,000 acres

SOURCE: U.S. Fish and Wildlife Service National Wetland Trends Study, 1982

*Photo credit: OTA Staff*

Wetlands are often attractive sites for real estate development because of their waterside location. This Louisiana housing development near New Orleans, for instance, is constructed on filled wetlands

### Table 2.—Major Federal Programs Affecting the Use of Wetlands

| Program or act | Primary implementing agency | Effect of program |
|---|---|---|
| ***I. Discouraging or Preventing Wetlands Conversions*** | | |
| A. *Regulation:* | | |
| Section 404 of the Clean Water Act (1972) | U.S. Army Corps of Engineers, Department of Defense | Regulates many activities that involve disposal of dredged or fill material in waters of the United States, including many wetlands |
| B. *Acquisition:* | | |
| Migratory Bird Hunting and Conservation Stamps (1934) | Fish and Wildlife Service (FWS), Department of the Interior (DOI) | Acquires or purchases easements on wetlands from revenue from fees paid by hunters for duck stamps |
| Federal Aid to Wildlife Restoration Act (1937) | FWS | Provides grants to States for acquisition, restoration, and maintenance of wildlife areas |
| Wetlands Loan Act (1961) | FWS | Provides interest-free Federal loans for wetland acquisitions and easements |
| Land and Water Conservation Fund (1955) | FWS, National Park Service (DOI) | Acquires wildlife areas |
| Water Bank Program (1970) | Agriculture Stabilization and Conservation Service, Department of Agriculture (USDA) | Leases wetlands and adjacent upland habitat from farmers for waterfowl habitat over 10-year period |
| U.S. Tax Code | Internal Revenue Service (IRS) | Provides deductions for donors of wetlands and to some not-for-profit organizations |
| C. *Other general policies or programs:* | | |
| Executive Order 11990, Protection of Wetlands (1977) | All Federal agencies | Minimizes impacts on wetlands from Federal activities |
| Coastal Zone Management Act (1972) | National Oceanic and Atmospheric Administration, Department of Commerce | Provides Federal funding for wetland programs in most coastal States |
| ***II. Encouraging Wetlands Conversion*** | | |
| U.S. Tax Code | IRS | Encourages farmers to drain and clear wetlands by providing tax deductions and credits for all types of general development activities |
| Payment-in-Kind (PIK) Program | USDA | Indirectly encourages farmers to place previously unfarmed areas, including wetlands, into production |

SOURCE: Office of Technology Assessment, 1983.

## *Federal Programs Discouraging Wetland Conversions*

### Federal Regulation—The 404 Program

Under the River and Harbor Act of 1899, the Corps regulates all activities that could directly affect the navigability of rivers and coastal waters used for interstate commerce. In 1972, Congress gave the Corps the responsibility of regulating the discharge of dredged or fill material in the Nation's waters under section 404 of the Clean Water Act (CWA). Through this program, the Corps evaluates the impacts of proposed development projects on wetlands in light of its review and comments from the Environmental Protection Agency (EPA), the Fish and Wildlife Service (FWS), the National Marine Fisheries Service (NMFS), and the States. If a project's impact on the environment is judged to be significant, the permit application can be denied, the project can be modified to minimize impacts, or the permit applicant can purchase or restore other wetlands to compensate for project impacts. EPA also has veto authority over any proposed sites for disposing of dredged or fill material. In this way, the 404 program provides broad regulatory authority over wetland use by many types of development activities.

The Corps initially interpreted the geographic scope of its new authority to include only traditionally navigable waters. However, after a 1975 decision by the District Court for the District of Columbia in *National Resources Defense Council, Inc.* v. *Callaway,* the scope of the 404 program was expanded to encompass "all waters of the United States." The issue of the Corps' expanded jurisdiction was hotly debated, but left unchanged in a close vote, when CWA was amended in 1977. Many view this broad authority as a significant extension of the Federal Government's constitutional powers that borders on land-use control; others view it as necessary to protect the public's interests in the quality of the Nation's waters.

**There are fundamental differences in the way Federal agencies and various special interest groups interpret the intent of section 404, which, as stated in the preface to CWA, is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (sec. 101[a]). The Corps views its primary function in carrying out the law as protecting the quality of water. Although wetland values are considered in project reviews, the Corps does not feel that section 404 was designed specifically to protect wetlands. FWS, EPA, NMFS, and environmental groups feel that the mandate of CWA obliges the Corps to protect the integrity of wetlands, including their habitat values.**

#### LIMITATIONS OF THE 404 PROGRAM

**The Corps' 404 program now provides the major avenue for Federal involvement in regulating activities that use wetlands; however, in terms of comprehensive wetland management, it has major limitations.**

First, in accordance with CWA, the 404 program regulates only the discharge of dredged or fill material onto wetlands. Projects involving excavation, drainage, clearing, and flooding of wetlands are not **explicitly** covered by section 404 and are not usually regulated by the Corps.* Yet such activities were responsible for the vast majority of inland wetland conversions between the mid-1950's and the mid-1970's. Rarely have these activities been halted or slowed because of Federal, State, or local wetland regulations. **Without more direct government involvement, the conversion of most inland wetlands is likely to continue unabated.**

Second, the Corps does not have adequate resources to regulate activities effectively in all waters of the United States. Instead of case-by-case review, it uses general permits for isolated waters and headwater areas. Because there are few application or reporting requirements for activities within areas covered by general permits, the Corps has limited regulatory control over these areas.

---

*The regulation of wetland draining and/or clearing operations for agricultural purposes is highly contentious and variable among Corps districts. Some conversions involving the discharge of fill material from ditching operations onto wetlands are regulated either individually or under general permits. Individual permits are usually issued with few modifications because of difficulties in demonstrating adverse water quality and/or cumulative impacts. Some conversions do not involve the discharge of fill material onto wetlands. Others are not regulated due to failure of the Corps' administration and lax enforcement or because the Corps and EPA may use a narrower definition of wetlands than scientists or environmental groups. Alternatively, farmers may convert potential "wetlands" in dry years when wetland vegetation is not present or they may drain wetlands through ditches on nonwetland areas. In accordance with present Corps policy, the clearing of bottom lands is not generally regulated by most districts, except in a portion of Louisiana as a direct result of a ruling by the Fifth Circuit Court. However, one Corps district has significantly slowed some large-scale clearing operations, although the extent of its jurisdiction is controversial.

Third, several administrative problems presently limit the program's effectiveness including significant variations in the way different districts implement key elements of the 404 program, the lack of coordination between some districts and other Federal and State agencies, inadequate public awareness efforts, and the low priority given monitoring and enforcement.

## EFFECTS OF THE 404 PROGRAM ON WETLANDS

Estimates made by OTA based on the best available information suggest that **present conversion rates are probably about 300,000 acres per year.*** Approximately 250,000 acres per year result from the unregulated conversion of inland wetlands, primarily for agricultural use, while 50,000 acres per year result from conversions regulated by the 404 program and State regulatory programs. Of this latter figure, about 5,000 acres are located in coastal areas.

According to their own estimates for 1980-81, the Corps authorized projects that, if completed in accordance with the conditions of the permits, resulted in the conversion of about **50 percent** of the acreage applied for. Data from NMFS for the coastal wetlands (in the lower 48 States) indicate that the 404 program, in combination with State regulatory programs, reduced the conversion of coastal saltwater wetlands by **70 to 85 percent** in 1981. In addition, some conversions may be deterred simply by the existence of the regulatory programs, and other conversions may be avoided through preapplication consultations with the Corps.

Finally, each year about 5,000 acres of vegetated wetlands are either created or restored for mitigation purposes as a direct result of the "conditioning" of 404 permits.

## EFFECTS OF THE 404 PROGRAM ON DEVELOPMENT ACTIVITIES

Developers' objections to the 404 program focus mainly on the delays and costs imposed by the regulatory process. There are probably numerous cases where the regulatory costs to developers have been substantial—in some cases, millions of dollars. But **little verifiable data are available to document the overall impacts of the 404 program on development activities,** especially as they relate to costs imposed by other programs and policies (e.g., sec. 10 of the River and Harbor Act, National Environmental Policy Act requirements, State programs, and local ordinances) and general economic conditions.

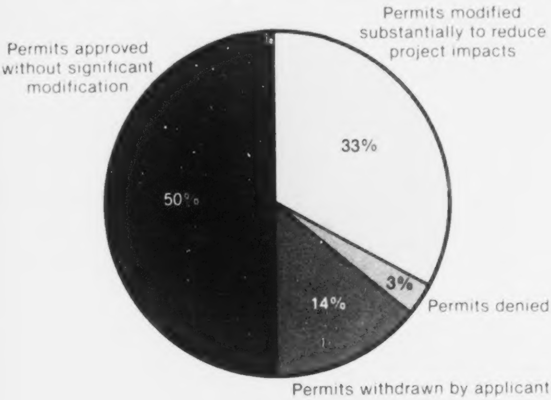
Some developers question the need for a Federal program to protect all wetlands; the congressional intent of section 404 relative to wetland protection; inadequate consideration by regulatory agencies of the value of development activities; inconsistencies in the program implementation by Corps districts; and possible inefficiencies or inequities in program administration, including duplication of State wetland programs. Many also believe that the market value of wetland areas decreases when they fall within the jurisdiction of the Corps' regulatory program.

**All permit applicants bear at least some 404-related costs resulting from permit denials, modifications of projects, permit processing, and processing delays.** Of approximately 11,000 project applications per year, slightly less than 3 percent are denied; about one-third are significantly modified; and about 14 percent are withdrawn by applicants (fig. E). About half are approved without significant modifications. In 1980 approximately one-third of all issued permits took longer than 120 days to process; in 1983 the average processing time was about 70 days. Less than 1 percent of all permitted projects require an Environmental Impact Statement (EIS), which may take several years to complete. **Delays in processing permit applications for a relatively few large-scale projects** (that represent the bulk of the economic value of all proposed development activities) **probably account for a substantial portion of the total costs to industry associated with the 404 program.**

---

*Because of uncertainties and variability associated with available data and the extrapolations that were made from these data, these estimates may be off by 10 to 20 percent.

**Figure B.—404 Permit Statistics, 1981**



Total number of permit applications: 11,000/year

SOURCES: U.S. Army Corps of Engineers and Office of Technology Assessment.

### Federal Economic Measures

**Since Federal outlays for wetland acquisitions, easements, and leases total only a few million dollars a year, economic measures can be used to protect wetlands only on a highly selective basis.** An estimated 10 million acres of wetlands in the lower 48 States are protected through Federal ownership, easements, and leases. Federal wildlife refuges also protect about 29 million acres of wetlands in Alaska.

Full ownership or easements provide the Government with the most effective mechanism for directly controlling the use of wetlands. **Full ownership** is probably most suited for situations where management of a wetland as part of the system of national refuges, parks, and forests is desired or where the goal is to preserve the wetland in perpetuity, regardless of the benefits of potential development activities. Perpetual **easements** provide almost the same level of control as full ownership, while the wetlands remain in private hands. Recent Federal costs of wetland purchases by FWS range from $600 to as much as $1,200/acre for some bottom lands. Easements typically cost the Government about $200/acre. Federal funding for wetland acquisition and easements is provided through sale of Migratory Bird Hunting and Conservation Stamps (duck stamps) and through the Wetlands Loan Act of 1961 and the Land and Water Conservation Act of 1965.

**Leases** can provide a high degree of Federal control for the period of the lease. Through the Department of Agriculture (USDA) Water Bank Program, authorized by the Water Bank Act of 1970, private landowners or operators generally receive, through 10-year leases, annual payments of $5 to $10/acre for most designated wetlands and up to $55/acre for adjacent upland areas.

**Tax writeoffs** are given to owners who donate wetlands to Government or conservation agencies.

## *Federal Programs Encouraging Wetland Conversions*

**Tax deductions and credits for all types of general development activities provide the most significant Federal incentive for farmers to clear and drain wetlands.** They also shift a significant portion of the conversion costs to the general taxpayer. The dollar value of these tax incentives is greater at higher income levels. They include:

- first-year tax deductions of up to 25 percent of gross farm income for draining expenses (expenses in excess of this limit may be deducted in subsequent years);
- tax deductions for depreciation on all capital investments necessary for draining or clearing activities;
- tax deductions for interest payments related to draining and clearing activities; and
- investment tax credits equal to 10 percent of the installation cost of the drainage tile.

**Price supports and target prices** for commodities may have encouraged some wetland conversion by setting guaranteed floor prices for some crops grown on converted wetlands, but few farmers have been enrolled in these programs over the past decade. Other USDA policies that may provide assistance for wetland conversions take the form of **technical assistance** and **cost-sharing** for the construction of a wide variety of conservation projects, **loans** from the Farmers Home Administration to finance conversions, and Federal compensation through **crop insurance** for crop losses from flooding in wetland areas. These forms of assistance are probably of limited significance in influencing a farmer's decision to convert wetlands to cropland.

### *Administration Policies*

The administration's goals with respect to wetlands are unclear. On the one hand, the Corps has revised its administrative procedures for the 404 program to reduce the regulatory burden on industry and to increase the role of the States. Some of these changes may have reduced the level of wetlands protection provided by 404, although there will never be quantitative data to support this or any other statement made about the effects of these programmatic changes on wetlands. Administration support for State coastal management programs also has been reduced significantly, and no funds have been requested in the past 3 years for wetland acquisition. On the other hand, the Department of the Interior proposed a bill, Protect Our Wetlands and Duck Resources Act (POWDR), to eliminate some Federal expenditures for some wetland activities, increase funding to States for wetland conservation, extend the Wetlands Loan Act for 10 years, and increase revenues for wetland acquisition through additional fees for duck stamps and wildlife refuge visitation permits.

### *State Wetland Programs*

**Almost all 30 coastal States (including those bordering the Great Lakes) have programs that directly or indirectly regulate the use of their coastal wetlands. Most inland States do not have specific wetland programs. Through a combination of the 404 program and State programs, most coastal wetlands are regulated reasonably well; inland wetlands, which comprise 95 percent of the Nation's wetlands, generally are not regulated by States.**

Developers often object to the apparent duplication between the 404 program and State regulatory programs. However, **representatives from most States with wetland programs believe that the 404 program and State regulatory programs complement one another.** Corps districts often let State agencies take the lead in protecting wetlands, using the 404 program to support their efforts. If certain EPA requirements are met, States can assume the legal responsibility for administering that portion of the 404 program covering waters that are not traditionally navigable. Twelve States have evaluated or are evaluating this possibility, and four are administering pilot programs to gain practical experience prior to possible program assumption. Michigan is the only State that has applied for 404 program assumption. **In general, most States have neither the capability nor the desire to assume sole responsibility for regulating wetland use without additional resources from the Federal Government; some States would be reluctant to do so even with government support.**

### *Local Wetland Programs*

In some areas of the country, the principal means of wetland protection outside of the 404 program comes from local regulations (including zoning controls) and acquisition programs.

### *Private Initiatives*

Private organizations, such as the Nature Conservancy, the Audubon Society, and Ducks Unlimited, have protected thousands of acres of wetlands through direct acquisition, partial interest, and other means. For example, the Richard King Mellon Foundation recently gave the Nature Conservancy a $25 million grant toward its efforts to conserve wetland ecosystems in the United States. Other national environmental organizations and hundreds of local or regional organizations, including fish and game clubs, have also been active in protecting wetlands.

## POLICY CONSIDERATIONS AND OPTIONS

### *Policy Considerations*

Controversy over the 404 program has led to much discussion of different ways of changing the Federal involvement in controlling the use of wetlands. Decisions about the use of wetlands are not usually simple and straightforward, but involve judgments about:

- the importance of wetlands to society relative to the benefits associated with wetland development;
- the relative significance of current rates of wetland conversion;
- the desirability of temporarily deferring the immediate benefits from wetland conversion to avoid the loss of potentially valuable resources;
- the adequacy of existing programs and the costs imposed by these programs on Government, development activities, and society at large; and
- the appropriate role of the Federal Government relative to the role of other levels of government and of private organizations.

In general, the greater the Federal involvement in controlling the use of wetlands, the greater the costs for wetland programs and for developers.

## Policy Issues

OTA has identified three issues related to wetlands management:

1. Should Federal involvement in protecting wetlands be increased or decreased?
2. Should the Federal Government improve its policymaking capability through a systematic collection and analysis of additional information about wetlands?
3. Should the Federal Government develop a more integrated approach for managing the use of wetlands?

These issues are interrelated. For example, if Congress determines that the existing data are adequate to resolve issue 1, it would not be necessary to pursue any policy options addressing issue 2. On the other hand, Congress may decide to adopt options under issue 2 before attempting to make any changes in the level of Federal involvement as discussed under issue 1. Developing an integrated system for managing wetlands use, as described under issue 3, would require collecting more data about wetlands, as outlined in options under issue 2.

## Policy Options

### Issue 1: Should Federal involvement in protecting wetlands be increased or decreased?

Arguments about the desired degree of Federal involvement in managing the use of wetlands can be made from three different positions. First, in favor of increasing the level of Federal involvement, it can be argued that wetlands provide many valuable natural benefits to the public. Yet, from 30 to 50 percent of this resource has been converted to other uses, and conversions continue. Because most States generally do not seem inclined to fill any gaps in the current Federal regulatory program, a stronger Federal presence at least in those States with weak programs may be indicated.

Others argue that wetlands have been converted to other uses at rates of only 0.5 percent a year, while present rates are probably even lower. Considering the great benefits that can derive from wetland conversions, regulatory costs stemming from delays and permit denials are a high price to pay for preserving a small percentage of the Nation's wetlands. Thus, the level of Federal involvement should be reduced even though wetland conversions might increase as a result of decreased regulation.

Third, it could be argued that existing Federal programs, including the 404 program, provide the appropriate level of wetlands management and protection overall. To some, existing data might not indicate an urgency to halt all wetland conversions, but wetlands (especially high-value wetlands) deserve some protection to avoid possible incremental losses over the long term. In addition, the scanty data on recent trends may provide little basis for changing existing policies until more information has been collected. Court decisions about the scope of the 404 program and its implementation by the Corps are also pending.

The use of privately owned wetlands is now controlled, to varying degrees, through a mix of economic measures and regulation. Numerous options exist for modifying policy to increase or decrease the present level of Federal involvement in managing and protecting wetlands.

### Issue 1A: Options to *increase* Federal involvement in managing wetlands

Federal involvement could be increased by adopting any or all of the following options, which are listed roughly in order of decreasing Federal control over wetlands use, program costs, and costs to developers. How significant these changes would be is unknown. A single new wetlands statute could be developed to combine existing policies with any of the following options; however, if changes are desired, it would likely be easier to modify existing statutes individually.

### Option 1: Broaden the scope of section 404 through legislation.

**Increase the types of activities covered by section 404.**—Projects responsible for the vast majority of past wetland conversions (excavation, drainage, clearing, and flooding of wetlands) are not **explicitly** covered by section 404 or regulated by most Corps districts. Increasing the types of activities covered by section 404 could reduce wetland conversions resulting from nonagricultural activities. Agricultural activities are so numerous that it would be impractical to regulate all of them; however, it is probably possible to regulate large-scale conversions. At present, not all clearing operations are regulated and few modifications or denials are made, even on those that are.

**Explicitly address wetland values in section 404.**—Because the term "wetland" is used only once in section 404 and is not defined, the objectives of CWA with regard to wetlands are open to interpretation. The regulation of wetland-clearing operations, particularly in bottom land areas, has been the subject of constant controversy. If wetland values were addressed explicitly in section 404, the Corps would have a clear mandate to consider and protect the integrity of wetlands (including habitat values) as well as water quality. If this were done, many wetland-clearing operations falling within the Corps' jurisdiction could be controlled.

### Option 2: Remove the incentive for agricultural conversions.

**Eliminate tax incentives for agricultural conversions.**—The cost of agricultural conversions to a farmer can be reduced through tax credits and deductions for costs associated with clearing and draining activities. Tax incentives could be reduced or eliminated for these activities if they occurred on wetlands. However, the effect of this change on wetland use would probably vary. In some areas of the country, wetland conversions could become unprofitable; in other areas, conversions probably would still be profitable even without Federal tax incentives.

The effects of eliminating these tax incentives would be insignificant to the vast majority of farmers and on the farm economy. For example, deductions for wetland conversions were less than 0.3 percent of all farming deductions in 1980. **In addition, because of the relatively large acreage of available cropland (i.e., 365 million acres), neither commodity prices nor farm production as a whole would be noticeably affected over the near term if agricultural conversion of wetlands were curtailed or eliminated.** Nonetheless, eliminating tax benefits to farmers for wetland conversions will never be popular.

**Increase appropriations for the Water Bank Program.**—The Water Bank Program, funded at $8.8 million in 1982 and 1983, preserves wetlands and adjacent uplands covered by the program for 10-year lease periods. Because the program is apparently popular with the agricultural community, additional appropriations would allow increased enrollment and greater coverage of wetlands in agricultural areas. The program might also be more attractive if payments were increased or adjusted annually in response to changing pressures to convert wetlands rather than every 5 years, as it is now.

**Encourage wetland preservation through the Payment-in-Kind Program.**—In 1983, USDA instituted its Payment-in-Kind (PIK) Program, wherein farmers withdrew cropland from production in exchange for commodities that would have been produced on the cropland. In fiscal year 1983, approximately 82 million acres of cropland were taken out of production as a result of the PIK Program. However, many farmers are apparently simultaneously putting other land, which could include wetlands, into production. If the PIK Program is used in future years, it may be possible to include special provisions that would encourage the preservation of wetlands.

**Option 3: Increase appropriations for acquisition and easement programs.**

The National Wildlife Refuge System contains over 33 million wetland acres: 4 million are in the lower 48 States and 29 million are in Alaska. The National Park System contains untabulated but substantial wetland acreage. Federal funding for these programs could be increased, and greater priority could be given to wetlands in purchasing decisions. Federal wetland-related income, such as the fee charged for duck stamps, could be increased to support these programs.

**Option 4: Increase tax benefits for wetland preservation through legislation.**

Congress could alter Federal taxation policies to increase the attractiveness of donating wetlands or of selling conservation easements to Government agencies or to private conservation groups for the purpose of preservation. While the acreage of wetlands being protected might increase, the ecological value of the wetlands donated would probably vary.

**Option 5: Reverse the Corps' 1982 administrative changes to the 404 program.**

The Corps' recent administrative changes to the 404 program have been designed to streamline the permit process. For example, average processing time for individual permits has been reduced from over 120 to about 70 days. Although the Army contends that the level of wetlands protection actually achieved has been unchanged by the administrative measures, anecdotal and qualitative evidence suggests that these changes, such as the expanded use of general permits, have generally reduced the amount of potential control over wetland use. However, existing data do not allow quantification of the effects of these administrative changes on wetland trends. Reversing these changes would reestablish the administrative framework for regulating wetland use at levels that existed before the administration's 1982 regulatory reform initiatives.

**Option 6: Improve the Corps' administration of the existing 404 program.**

The efficiency and effectiveness of the 404 program could be improved by implementing the following measures, which may require modest increases in program funding and personnel. Congressional oversight may also be required to determine the extent to which these options are implemented by the Corps.

**Standardize Corps' district procedures.**—The Corps' 404 program is implemented by 38 semiautonomous district offices that often differ greatly in how they interpret and implement the 404 program. Some inconsistencies could be avoided through continued and increased use of regulatory-guidance letters on presently vague policies, such as those on the mitigation of project impacts. Districts also could exchange information about successful solutions to common problems.

**Improve coordination among Federal agencies and between the 404 and State regulatory programs.**—Improved coordination, increased use of single public notices, and joint processing of permit applications could provide "one-stop shopping" for permit applicants and reduce procedural duplication and delays. Procedures of this sort already have been successfully implemented in a few Corps districts.

**Increase program publicity.**—Many people planning development activities on wetlands are unaware of the 404 program and its permit requirements. Greater public understanding could lead to better planning and result in fewer violations, less damage to wetlands, and reduced costs to developers stemming from delays and fines.

**Improve monitoring and enforcement.**—Many districts make inadequate efforts to monitor for permit violations, particularly in inland wetland areas. Action is often taken only in response to reported violations. This situation could be improved by increasing district funding, using personnel specifically for this purpose, and by providing equipment (e.g., observation planes) as needed. A congressional mandate may also be required.

**Establish reporting requirements for general permits.**—The Corps does not monitor activities covered by general permits or the impacts of such activities on wetlands. More complete reporting could be required so that individual and cumulative impacts associated with individual projects could be assessed. If reports indicated unacceptable impacts, permit requirements could be strengthened.

### Issue 1B: Options to *decrease* Federal involvement in managing wetlands

If Federal involvement in protecting wetlands appears to Congress to be too great, a number of options could be adopted. Some options reduce funding for Federal programs; others reduce the scope of the 404 program. Legislative action is desired by some who favor extensive and permanent reforms in the program. The following options for decreasing the level of Federal involvement will also decrease wetlands protection, costs for the Federal Government, and regulatory costs to developers. How great these decreases will be is unknown.

#### Option 1: Amend section 404.

In a February 10, 1983, letter to EPA, the Assistant Secretary of the Army (Civil Works) outlined several possible legislative changes to section 404, including the options below. OTA analysis indicates that any combination of these options that includes **either** of the first two changes probably would provide a level of Federal wetland regulation and 404-related costs to industry similar to those that existed prior to full implementation of the 404 program.

**Transfer the 404 program to the States.**—Most coastal wetlands are reasonably well regulated by 404 and State programs; most inland wetlands are not. In those coastal States with strong wetland programs, transfer of the 404 program to the States probably would not affect wetland use in a major way. In States with relatively weak or no programs, such an option would reduce control over wetlands, especially inland wetlands, unless the Federal Government provided large amounts of financial and technical assistance to strengthen State programs. Even with assistance, some States still might not effectively regulate wetland use.

**Expand the use of general permits to include all projects other than those occurring in traditionally navigable waters.**—Since monitoring and enforcement requirements for general permits are usually not a high priority in most Corps districts, development of most wetlands would, for all practical purposes, be uncontrolled by the Federal Government. Instead, States would have primary responsibility for regulating the use of most wetlands.

**Eliminate permitting requirements for any incidental discharges.**—If section 404(f)2 were eliminated, it would be very unclear whether or not the Corps would be required to regulate discharges of dredged or fill material that are incidental to activities that convert waters of the United States to a new use. Thus, the clearing of wetlands, such as the bottom land hardwoods, would probably become less stringently regulated than it is at present.

**Make 404(b)1 guidelines only advisory in nature.**—Section 404(b)1 guidelines are developed by EPA in conjunction with the Corps. Through this change, EPA's role in the 404 program would be significantly reduced and nonenvironmental factors could be used by the Corps to override environmental concerns.

**Give the Corps sole authority to define "dredged material" and "fill material" and activities that constitute a discharge.**—This provision would eliminate EPA's current legal involvement in Corps decisions about what activities and types of fill material, such as garbage, would be regulated.

#### Option 2: Decrease appropriations for acquisition, easement, and leasing programs.

The Federal Government spends several million dollars each year for wetland acquisition, easements, or leases. Federal funding for these programs could be decreased; similarly, lower priority could be given to wetland purchases. Either action would have little effect on industry.

#### Option 3: Rescind Executive Order 11990.

Regulations developed by many Federal agencies in response to Executive Order 11990, Protection of Wetlands, could be rescinded. This would allow, for instance, Federal assistance to farmers for wetland drainage.

### Issue 2: Should the Federal Government improve its policymaking capability through a systematic collection and analysis of additional information about wetlands?

At this time there is uncertainty about **current trends** in wetland use, the **environmental significance** of further wetland conversions, and the current **effects of major policies and programs** on wetlands. Whether or not additional information should be collected depends on a judgment about its potential contribution to Congress' policymaking capability and its value to Federal program administrators. For some people, the available information may be adequate for setting present and future wetland policy. Further information, while perhaps useful in fine-tuning policies, may seem unwarranted given the cost. In this case, option 1 might be selected. On the other hand, existing uncertainties may make it difficult to isolate realistic policy choices and to determine the effect of these options. For instance, it may be difficult for some to decide what changes, if any, should be made to section 404 without better knowing how the current program has affected trends in wetland use. In this latter case, option 2 could be selected.

**Option 1: No, current information is adequate.**

For some policymakers, existing information may be adequate to make present and future decisions about wetland policies and programs. Some new information will be collected as the result of existing Federal programs. In particular, FWS is planning to update its analysis of national trends to cover the 10-year period following the mid-1970's. Also, EPA, FWS, NMFS, and the Corps will continue to conduct research on wetland values.

**Option 2: Yes, collect additional information.**

For other policymakers, making decisions about wetland policies and programs may be difficult at this time because of major gaps in technical information. Past efforts have primarily supported the missions of the agencies conducting the research, rather than the policymaking process. Congress' policymaking capability could be significantly improved if the **three concurrent research elements** described below were undertaken. To ensure that the results produced by these efforts are brought to bear on the overall policymaking process, an **integrated plan** (with budgets and schedules) for conducting and coordinating all these policy-related activities could be developed by an **interagency working group** headed by a Federal agency. This information would not necessarily be available unless Congress takes steps to ensure its collection.

**Element 1: Determine recent trends of wetland use.**—The FWS's recently completed statistical analysis of wetland trends provides information on wetland use only between the mid-1950's and the mid-1970's. As currently planned, FWS will update its analysis of national trends to cover the 10-year period following the mid-1970's. However, better information on regional trends could be collected to determine where wetland-conversion rates are most critical and where development pressures are greatest. Such regional analyses would entail an increase in the number of sites surveyed.

**Element 2: Evaluate the significance of additional wetland conversions.**—The extent to which the environment will be degraded by additional conversions of wetlands is known only in a few cases. For example, if all the prairie potholes in the upper Midwest were lost, we know that North American duck populations would decrease by about half. On the other hand, we do not know the importance of wetland-derived detritus for estuarine fish and shellfish populations relative to other sources of food, such as algae and detritus from upland areas. Yet this type of information provides a technical basis for changing levels of protection for specific types of wetlands. A detailed understanding of all wetland systems in the United States is not necessary; much could be learned from a small number of long-term studies of wetland systems within specific physiographic regions, river basins, or estuaries.

**Element 3: Further analyze the effect of major policies and programs on wetlands use.**—Additional analysis by an interagency working group on the effects of Federal and State wetland programs on wetland trends could provide a basis for modifying existing programs, especially in light of the results of the two options just discussed. For example, the Corps could compile more thorough information on project acreages and types of wetlands impacted. In addition, a detailed evaluation of the capabilities and limitations of State programs, individually and in combination with the 404 program, could indicate possible ways of improving the efficency and effectiveness of different programs that have a major effect on wetlands.

**Issue 3: Should the Federal Government develop a more integrated approach for managing wetlands?**

About 5 percent of the lower 48 States, or about 90 million acres, is covered by wetlands. These wetlands are geographically dispersed and their relative abundance varies from region to region. In some regions, wetlands provide important ecological services; in other regions, their values are primarily intrinsic (e.g., wilderness, esthetic, recreation, etc.). Wetlands of widely different value can be found in the same regions. Due to the inherent variability among wetland values, their wide and variable distribution, and the large number of conversion activities (i.e., a few tens of thousands) that are proposed each year, **the use of wetlands is difficult to manage.**

**Federal wetland programs generally deal with wetlands in a piecemeal manner;** that is, each program generally focuses on certain ecological services, wetland types, and/or geographic areas. For example, FWS acquisition and easement programs focus mainly on protecting wetlands (and upland areas) that are important for wildlife. However, many wetlands that provide other ecological services, such as flood control, might also warrant acquisition. USDA's Water Bank Program leases valuable waterfowl nesting and breeding habitat in prime agricultural areas of the country. Leasing of nonagricultural areas to protect other ecological services is not within the scope of this program.

An integrated approach for managing wetlands could be considered.

**Option 1: Yes, an integrated approach for managing wetlands use should be developed.**

This integrated approach would involve "tailoring" or adjusting existing acquisition, leasing, or regulatory policies on a regional basis to wetlands of different values and to different development activities prior to possible wetland conversion.

Developing an integrated approach to wetlands management would involve **four sequential steps.** First, the FWS's ongoing inventory of wetlands would be continued or accelerated. Second, the wetlands in an inventoried region would be categorized according to their relative values. Third, existing wetland policies and programs would be "tailored" or adjusted according to their category and specific characteristics. For example, higher value wetlands covered by 404 could be stringently regulated through individual permits; lower value wetlands could be covered by less stringent general permits. Fourth, different Federal, State, or local programs could be applied to different wetland categories and types of development activities in a more integrated fashion.

This approach has several advantages. High-value wetlands with different ecological services could be given an appropriate level of protection. Agency funding and personnel could be focused on high-value wetlands in different regions of the country rather than all wetlands in general or wetlands that provide a single ecological service. Regulators, developers, and the public would be aware of the status of the wetlands in their particular areas prior to any proposals to convert them to other uses. Developers also would have prior knowledge about standards and requirements for converting specific wetland areas. The time required for processing most 404 permits would be significantly reduced. Finally, decisions about wetland use would be more predictable and consistent.

The four steps involved in this approach are described in more detail in the following discussion.

**Step 1: Continue or accelerate the ongoing mapping of wetlands by FWS.**—At this time, a detailed inventory of 30 percent of the wetlands in the lower 48 States and 4 percent in Alaska has been completed. An additional 5 percent of the lower 48 States and 2 percent of Alaska can be mapped each year at an annual cost of $3.5 million per year. With greater funding, this inventory effort could be accelerated.

**Step 2: Categorize wetlands.**—Once inventoried, wetlands would then be placed in three to five broad categories based on the combined importance of their ecological services and intrinsic values. In about a dozen areas in the United States, wetlands have been inventoried and broadly categorized in this manner. One case, the Anchorage (Alaska) Wetland Plan, places wetlands in four categories: **preservation,** which precludes any development activities; **conservation,** which allows limited conversions with measures to mitigate impacts; **developable,** which allows complete draining and filling without a permit; and **special study,** which requires collecting additional environmental data to determine wetland status. Local authorities use this plan to control the conversion of wetlands under a general permit from the Corps.

Categorizing wetlands would involve weighing and integrating the values of different ecological services within a political rather than strictly scientific framework. Therefore, categorization could best be accomplished by Federal policymakers from an interagency working group in cooperation with regional groups composed of State and local officials, wetland scientists, developers, and the general public who would be familiar with wetland values in their respective physiographic regions or river basins. This process also would involve regional public hearings.

**Step 3: Tailor existing policies and programs.**—After categorizing the wetlands in a certain region, Federal, State, **or** local wetland policies and programs would then be selectively applied by program administrators according to the relative values of different wetlands, as well as the values and impacts of potential development activities. For example, wetlands covered by the 404 program, depending on their natural values, could be individually regulated, covered by general permits, or left unregulated. For wetlands that are individually regulated, the procedures used to review permits and mitigate impacts could reflect the relative values of the wetlands, as well as the type, size, and benefits associated with development activities. Acquisition and leasing programs could be easily focused on high-value wetlands identified by the inventory.

The tailoring process would not be designed to disallow all further wetland conversions. Instead, the inventory and categorization of wetlands would provide a management tool for program administrators, developers, and policymakers in making decisions about the use of wetlands based on their relative values. All wetlands in the United States would not have to be mapped prior to the tailoring of policies; tailoring would be accomplished as the different regions are mapped. The highest priority could be placed on those areas where many important wetlands are located and/or where conversion pressures are greatest.

**Step 4: Integrate wetland policies and programs.**—Step four would first involve increasing the scope of existing wetland policies and programs to include the full range of natural wetland values. For example, acquisition and leasing programs, which now focus primarily on protecting habitats with high wildlife values, could be given programmatic flexibility by Congress to consider all wetland values. USDA's Water Bank Program for leasing waterfowl habitat in agricultural regions could be broadened to allow leasing of inland wetlands with a range of ecological values in both agricultural and nonagricultural areas.

If Congress increased the scope of different wetland programs, the interagency and regional groups organized in step 2 could select the most appropriate policies or programs for managing different wetland areas—whether through acquisition, easements, or regulation. For example, undegraded, high-value wetlands could be given a higher level of protection than they now have through direct acquisition or easements rather than regulation. Combinations of different policies might also be used for some wetlands. For example, if certain kinds of development activities on a privately owned wetland were prohibited within the framework of Federal or State regulations, the owner might be given the option to sell the wetland or an easement to the Federal or State Government.

If Congress wished to develop such an integrated approach, the gaps in policy-related information (discussed under issue 2) must be filled. Also, to ensure that all ongoing activities are relevant both to the missions of the involved Federal agencies and to the policymaking process in general, an integrated and detailed **work plan** could be developed by the interagency working group. In this way, the Federal Government could take advantage of the collective expertise and interests of the different Federal agencies that deal with wetlands. This plan should include a description of ongoing and planned activities, agency responsibilities, coordination procedures, funding requirements, and opportunities for congressional oversight. Above all, the plan would describe in detail the processes that would be used to tailor and integrate wetland policies and programs. This plan, which could be developed over a 2-year period at a cost this study estimates to be about $1 million, could provide an overall framework for wetland policymaking that would be stable over several administrations. The development and implementation of such a plan would require a congressional mandate with accompanying appropriations.

**Option 2: No. The existing approach for managing wetlands is adequate.**

Some wetland scientists and many environmentalists have serious reservations about this integrated approach. While they agree that some wetlands are more valuable than others, they believe that all wetlands should be stringently protected; tailoring would only weaken the protection that wetlands now have. There is also concern about yet-to-be-developed procedures for implementing the concept. For example, wetlands can be ranked according to their relative importance for single ecological services; however, it is not clear how the multiple ecological services and intrinsic values of each wetland would be considered and weighed during the categorization process. Important or yet-to-be-discovered services could be overlooked. Also, the relative values of wetlands may change over time. Therefore, some wetlands, especially those that fall outside the framework of State and Federal regulations, might not receive an adequate level of protection. Other institutional concerns focus on the uncertainties about the administration of the tailoring process, the potential for controversy and for the use of political influence, and the possible high costs associated with implementing such an approach.

OTA recognizes that there are uncertainties about developing an integrated approach for managing wetlands. However, if the tailoring concept is politically acceptable, it should be possible to establish acceptable procedures for implementing the tailoring process effectively. In light of existing uncertainties and concerns about tailoring, it may be desirable first to test the viability of procedures in several regions of the country on a pilot scale prior to making a decision about the desirability of full-scale implementation.

# Chapter 2

# Wetland Types

*Photo credit: U.S. Fish and Wildlife Service, Urban C. Nelson*

# Contents

Page

**Chapter Summary** ........ **25**

**Origins of Wetlands** ........ **25**

Glaciation ........ 25

Erosion and Sedimentation ........ 25

Beaver Dams ........ 26

Freezing and Thawing ........ 26

Activities of Man ........ 27

Miscellaneous Processes ........ 27

**Hydrologic Characteristics of Wetlands** ........ **28**

**Wetland Vegetation** ........ **28**

**Major Types of Wetlands and Closely Related Habitats** ........ **29**

Inland Freshwater Marshes ........ 29

Inland Saline Marshes ........ 30

Bogs ........ 30

Tundra ........ 30

Shrub Swamp ........ 30

Wooded Swamps ........ 30

Bottom Lands and Other Riparian Habitats ........ 30

Coastal Salt Marshes ........ 31

Mangrove Swamps ........ 31

Tidal Freshwater Marshes ........ 32

**Geographic Distribution of Wetland Types** ........ **32**

**Chapter 2 References** ........ **33**

## TABLE

*Table No.* *Page*

3. Locations of Various Wetland Types in the United States ........ 32

## FIGURES

*Figure No.* *Page*

1. General Distribution of Wetlands of the United States ........ 26
2. Cross-Sectional Diagram of New England-Type Salt Marsh ........ 29
3. Physical Subdivisions ........ 33

# Chapter 2
# Wetland Types

## CHAPTER SUMMARY

Wetlands, including marshes, swamps, bogs, bottom lands, and tundra, occur along sloping areas between upland and deepwater environments, such as rivers, or form in basins that are isolated from larger water bodies. Wetlands are either periodically or continually inundated by water and generally covered by vegetation adapted to saturated soil conditions that emerges through any standing water. Most wetlands have formed as a result of past glaciation, erosion and sedimentation, beaver activity, freezing and thawing in arctic areas, activities of man, and other processes.

## ORIGINS OF WETLANDS

The U.S. Fish and Wildlife Service (FWS) used the term "wetland" in 1952 to describe a number of diverse environments, typically of high productivity, that share characteristics of both aquatic and terrestrial habitats—i.e., they are at least temporarily inundated and have "emergent" vegetation adapted to saturated soil conditions. While a wide range of environmental conditions exist within this categorization—from salt marshes flooded and exposed daily to bottom land forests inundated only during spring flooding—wetlands also share similar hydrologic and habitat characteristics. These characteristics primarily stem from three interrelated factors: the wetland's origin, hydrology, and vegetation.

Six basic processes are responsible for wetland formation: glaciation, erosion and sedimentation, beaver dams, freezing and thawing, activities of man, and miscellaneous processes (6).

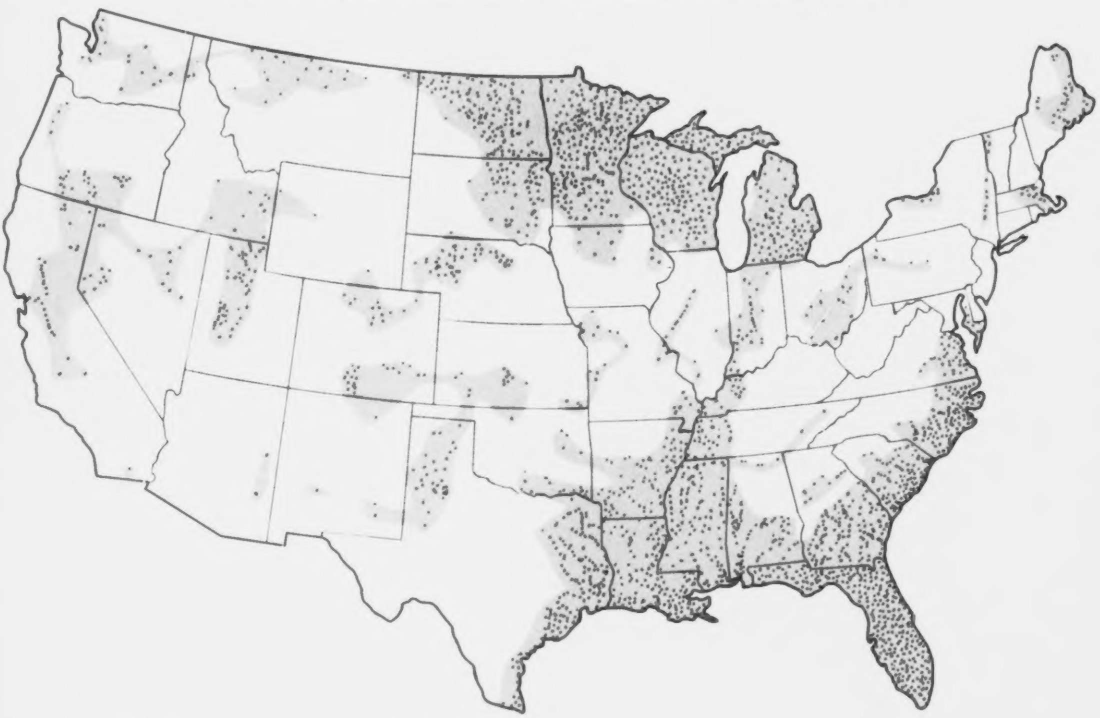
### *Glaciation*

A principal band of wetlands (fig. 1)—lying along the northern tier of the United States, including Alaska, Maine, New York, Michigan, Wisconsin, Minnesota, North Dakota, and Washington—was formed in three ways as glaciers melted 9,000 to 12,000 years ago. First, the melting of large blocks of ice left by receding glaciers created pits and depressions in glacial moraines, till, and outwash. Lakes and wetlands formed where the depressions intersected the ground water table or where fine clay and organics sealed their bottoms and permitted the collection of runoff waters. The majority of wetlands in the Northern United States were formed in this manner. Second, glaciers dammed rivers, often creating glacial lakes, sometimes thousands of square miles in area. Once the ice retreated, the lakes were drained partially, resulting in extensive low-lying areas with peat deposits. These areas form some of the large wetlands in the once glaciated Northern States. Third, glaciers scooped out and scoured river valleys and soft bedrock deposits, creating large and deep lakes such as the Great Lakes, and shallow depressions and wetland areas, such as the prairie potholes.

### *Erosion and Sedimentation*

Another principal band of wetlands is found (fig. 1) along the gulf and Atlantic coasts, where sediment has been deposited in the still waters behind barrier islands or reefs and in bays and estuaries. Wetland formation is favored by low-elevation topography along the Atlantic and gulf coasts. The sediment deposited behind Georgia coastal marshes, for instance, may be up to 10 meters in thickness and has formed extensive flat or gently sloping topography conducive to growth of wetland plants.

**Figure 1.—General Distribution of Wetlands of the United States**



Note: Shaded portions incorporate general wetland areas. Each dot represents about 10,000 acres.

SOURCE: Adapted from Samuel P. Shaw and C. Gordon Fredine, "Wetlands of the United States: Their Extent and Their Value to Waterfowl and Other Wildlife," Fish and Wildlife Service, U.S. Department of the Interior, Circular 39, 1956.

Major wetlands also are located along the flood plains of low-gradient rivers such as the Mississippi. River flood plains are created by the deposition of river alluvium on adjacent lands during floods. Rivers may cut new channels, abandoning old water courses, which may then become lakes or wetlands. Extensive wetland areas, such as the Mississippi Delta, are found where sediment is deposited at the mouths of rivers and streams. The deposition of sand, gravel, or silt also can create wetlands along the shores of, or adjacent to, lakes. Vast marshes of this type form along the Great Lakes.

## *Beaver Dams*

At one time, beaver dams played a major role in forming smaller inland wetlands in the forested areas of the Nation. While beaver populations fluctuate due to variability in trapping pressure, their presence can be a major factor in increasing wetland acreage in some regions of the country. For example, in an analysis of wetland trends in 15 Massachusetts towns between 1951 and the 1970's, beaver activity was the third most important cause of increases in wetland acreage out of 11 identified factors (9).

## *Freezing and Thawing*

In the Arctic, wetlands are created when the Sun melts the surface of frozen organic soils while the underlying soil remains permanently frozen. In addition, frost action segregates rock and soil particles of various sizes and shifts them in such a way that shallow, water-filled basins are formed.

Photo credit: Bob Friedman, OTA staff

Waubesa marsh near Madison, Wis., began its development approximately 6,000 years ago with the filling in of a shallow lake created by a retreating glacier. The majority of wetlands in the Northern United States were created by similar processes

## Activities of Man

Wetlands may develop naturally adjacent to reservoirs, farm ponds, irrigation canals, and in pits and depressions created by mining. Poor drainage due to construction of highways, levees, and buildings also can lead to the development of wetlands. Finally, manmade wetlands can be created intentionally by Federal, State, and local resource agencies and by conservation groups in shallow, protected waters.

## Miscellaneous Processes

Wetlands may be formed by other special processes. In the Sandhills of Nebraska and in other areas of the arid West, depressions have been formed by wind action. The Everglades exist because of a flow of ground water and surface water over bedrock at and directly below the surface. In Kentucky, Indiana, and several other States, wetlands are also found in sink holes and other areas where bedrock has been dissolved by percolating water. Geologic movements have shaped still other wetlands. Reelfoot Lake in Tennessee, for example, was formed by the sudden sinking of the earth from earthquakes. Similarly, San Francisco Bay was formed by movement along the San Andreas Fault.

## HYDROLOGIC CHARACTERISTICS OF WETLANDS

Wetlands may be located on the transitional sloping areas between upland and deepwater environments where the water is shallow and calm enough for emergent vegetation to grow. Wetlands also may form in basins that generally are isolated from larger water bodies. These basins: 1) are either at or below the ground water table, or 2) because of poor drainage, retain much of the water that flows into them. The interaction among the hydrologic regime, the wetland topography, and its underlying substrata (e.g., soil) largely controls the general characteristics of a wetland and most, if not all, of the ecological services that it performs.

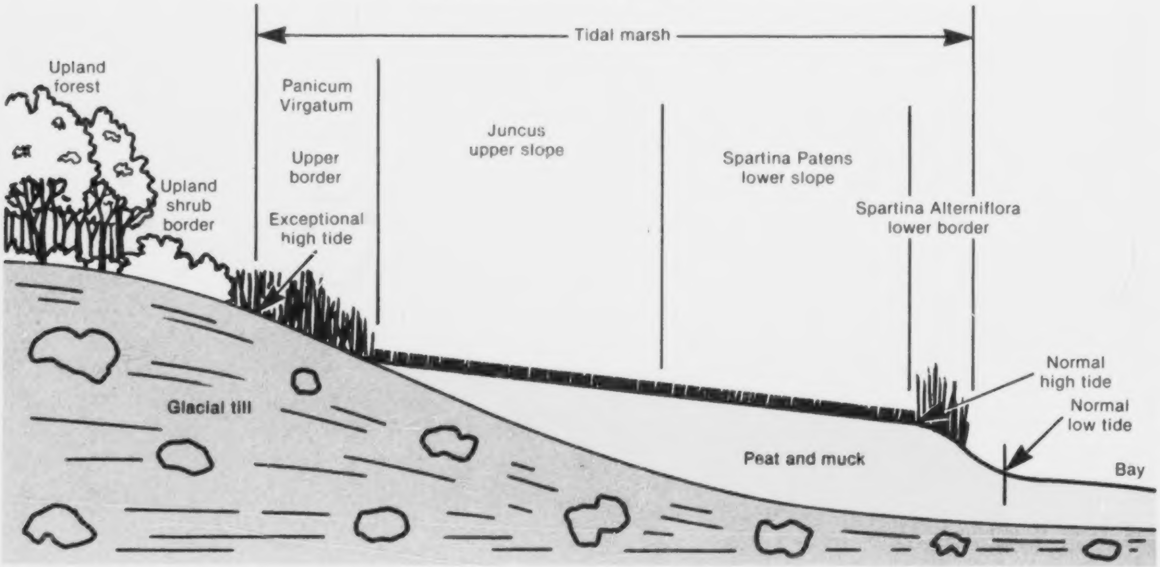
The two hydrologic characteristics that have the greatest influence in ultimately determining the habitat values of a wetland are the *depth of the water* and the *pattern of fluctuation of water depth* (8). The average depth of water varies greatly among wetlands. Bogs, for instance, typically are saturated to their surfaces, but rarely have standing water. In contrast, a wooded swamp or deep marsh may have standing water several feet deep. Annual fluctuations in water level also vary widely, ranging from those that are wet year-round, to those inundated irregularly for only a fraction of the year, to those flooded and exposed daily by tidal action. One of the most important factors influencing average water depth and patterns of fluctuation is the source of water, whether from direct surface runoff of snowmelt, from a river during spring flooding, or from tidal action in coastal areas. Climate, in addition to influencing the source of water—precipitation, snowmelt, and flooding—also determines seasonal patterns of drying. In the prairie-pothole region of the United States, for instance, shallow wetlands may dry out completely in some years.

## WETLAND VEGETATION

A diversity of plant forms is found in wetlands, ranging from deciduous trees to rooted floating plants, such as water lilies. Depending on the soil type, water availability, water quality, and temperature patterns, the dominant plants in wetland areas may be mosses, grasses, sedges, bulrushes, cattails, shrubs, trees, or any combination of these. A common distinction among wetland types is the vegetation type: trees or shrubs dominate swamps; grasses, sedges, cattails, and bulrushes dominate marshes; and mosses and lichens dominate bogs.

With the exception of the severe, limiting effect of high salinity on plant type, water depth and fluctuation are perhaps the dominant physical factors influencing the type and distribution of plants. Plants often have a narrowly defined tolerance for hydrologic conditions. In a typical New England salt marsh, for instance, *Spartina alterniflora* (salt marsh cordgrass) dominates the water's edge; as the marsh gains elevation, *Spartina patens* (saltmeadow cordgrass), and then *Juncus* (rushes) dominate the marsh (see fig. 2). In a freshwater marsh, a typical progression from deep to shallow water would include hard-stemmed bulrush, narrowleaf cattail, and broadleaf cattail. Bald cypress, black willow, willow oak, and swamp chestnut oak are representative species found in a bottom land hardwood forest, from the areas most regularly flooded to those irregularly inundated.

**Figure 2.—Cross-Sectional Diagram of New England-Type Salt Marsh (from Miller and Egler, 1950)**


Tidal marsh
Upland forest
Panicum Virgatum
Upper border
Exceptional high tide
Juncus upper slope
Spartina Patens lower slope
Spartina Alterniflora lower border
Upland shrub border
Normal high tide
Normal low tide
Glacial till
Peat and muck
Bay

Diagrammatic cross-section of the upland-to-bay sequence, showing the characteristics of the major vegetational units. Vertical scale much exaggerated.

SOURCE: H. T. Odum, B. J. Copeland, and E. A. McMahan, *Coastal Ecological Systems of the United States*, vol. 2 (Washington, D.C.: The Conservation Foundation, 1974).

# MAJOR TYPES OF WETLANDS AND CLOSELY RELATED HABITATS

Although FWS has developed a comprehensive system for classifying wetlands, for the purposes of this general discussion, OTA has distinguished between very broad types of wetlands using more vernacular terms. The primary factors distinguishing these types of wetlands are:

1. location (coastal or inland),
2. salinity (freshwater or saltwater), and
3. dominant vegetation (marsh, swamp, or bog).

## *Inland Freshwater Marshes*

Inland freshwater marshes may occur at any latitude but are not common at very high altitudes. Their water depths generally range from 6 inches to 3 feet. Marsh vegetation is characterized by soft-stemmed plants, grasses, sedges, and rushes that emerge above the surface of the marsh. They include such common plants as water lilies, cattails, reeds, arrowheads, pickerel weed, smartweed, and wild rice (3).

## Inland Saline Marshes

Inland saline wetlands occur primarily in shallow lake basins in the Western United States. They are usually saturated during the growing season and often covered with as much as 2 or 3 feet of water. Vegetation is mainly alkali or hard-stemmed bulrushes, often with widgeon grass or sago pondweed in more open areas (13).

## Bogs

Bogs occur mostly in shallow lake basins, on flat uplands, and along sluggish streams. The soil, often consisting of thick peat deposits, usually is saturated and supports a spongy covering of mosses. Woody or herbaceous vegetation, or both, also may grow in bogs. In the North, leather-leaf, Labrador tea, cranberries, and cotton grass often are present. Cyrilla, persea, gordonia, sweetbay, pond pine, Virginia chain fern, and pitcher plants grow in southern bogs, which are found on the Southeastern Coastal Plain. These bogs are more commonly known as "pocosins" (13).

## Tundra

Tundra is essentially a wet arctic grassland dominated by lichens (reindeer moss), sphagnum mosses, grasses, sedges, and dwarf woody plants. It is characterized by a thick, spongy mat of living and undecayed vegetation that often is saturated with water. Its deeper soil layer or permafrost remains frozen throughout the year; the surface of the tundra is dotted with ponds when not completely frozen. In Alaska, wet tundra occurs at lower elevation, often in conjunction with standing water; moist tundra occurs on slightly higher ground. An alpine tundra or meadow, similar to the arctic tundra, occurs in high mountains of the temperate zone (10).

## Shrub Swamp

Shrub swamps occur mostly along sluggish streams and occasionally on flood plains (13). The soil usually is saturated during the growing season and often is covered with as much as 6 inches of water. Vegetation includes alder, willows, button bush, dogwoods, and swamp privet.

## Wooded Swamps

Wooded swamps occur mostly along sluggish streams, on flood plains, on flat uplands, and in very shallow lake basins. The soil is saturated at least to within a few inches of its surface during the growing season and often is covered with as much as 1 or 2 feet of water. In the North, trees include tamarack, white cedar, black spruce, balsam, red maple, and black ash. In the South, water oak, overcup oak, tupelo gum, swamp black gum, and cypress are dominant. In the Northwest, western hemlock, red alder, and willows are common. Northern evergreen swamps usually have a thick ground covering of mosses. Deciduous swamps frequently support beds of duckweeds, smartweeds, and other herbs (13).

## Bottom Lands and Other Riparian Habitats

Riparian habitats, those areas adjacent to rivers and streams, are most commonly recognized as bottom land hardwood and flood plain forests in the Eastern and Central United States and as streambank vegetation in the arid West. Riparian ecosystems are unique, owing to their high species diversity, high species densities, and high productivity relative to adjacent areas (1).

Bottom lands occur throughout the riverine flood plains of the Southeastern United States, where over 100 woody species occur. Bottom lands vary from being permanently saturated or inundated throughout the growing season at the river's edge to being inundated for short periods at a frequency of only 1 to 10 years per 100 years at the uplands edge (7). On the lowest sites that are flooded the longest, most frequently, and to the greatest depths, bald cypress, tupelo gum, button bush, water elm, and swamp privet are most abundant. As elevation increases (and flooding frequency and depth decrease), overcup oak, red maple, water locust, and bitter pecan occur. Nuttall oak, pin oak, sweet gum, and willow oak appear where flooding occurs regularly during the dormant season but where water rarely is present at midsummer. Sites nearest the high-water mark, which are flooded only occasionally, have shagbark hickory, swamp chestnut oak, and post oak (4).

Photo credit: U.S. Fish and Wildlife Service

Bottom lands occur throughout the riverine flood plains of the Southeastern United States. They vary from being permanently inundated at the river's edge to being inundated for only short periods at a frequency of 1 to 10 years per 100 years at higher elevations

Riparian habitats in the arid West are scattered widely along ephemeral, intermittent, and permanent streams that commonly flow through arid or semiarid terrain. Woody vegetation associated with these wetlands includes willows and alders at higher elevations; cottonwoods, willows, and salt cedar at intermediate vegetations; and salt cedar, mesquite, cottonwoods, and willows at lower elevations (5).

## *Coastal Salt Marshes*

Salt marshes alternately are inundated and drained by the rise and fall of the tide. Because the plants and animals of the marsh must be able to adjust to the rapid changes in water level, salinity, and temperature caused by tides, only a relatively small number of plants and animals are able to tolerate these conditions. Thus, there is a high degree of similarity in the kinds of species present. Plants of the genus *Spartina* and the species *Juncus* and *Salicornia* are almost universal in their occurrence in U.S. salt marshes (12).

## *Mangrove Swamps*

Mangrove is a term denoting any salt-tolerant, intertidal tree species. In the United States, mangroves are limited primarily to Florida coastal areas. Large mangrove-swamp forests are found only in south Florida and are especially extensive along the protected southwestern coast (2). On the northwest Florida coast, black mangrove occurs mostly as scattered scrublands. On the eastern shore of Florida and along the Louisiana coast, mangroves are found behind barrier islands and on the shores of protected coastlines.

### *Tidal Freshwater Marshes*

Tidal freshwater marshes occur in virtually every coastal State but are most abundant in the estuaries of the mid-Atlantic coast and along the coasts of Louisiana and Texas. Dominant intertidal plants include a mixture of grasses and broadleaf species, such as arrow arum, spatterdock, pickerel weed, and arrowhead, which form rather complex multilayered plant zones. The upper marsh may have from 20 to 50 species of grasses, shrubs, ferns, and herbaceous plants (11).

## GEOGRAPHIC DISTRIBUTION OF WETLAND TYPES

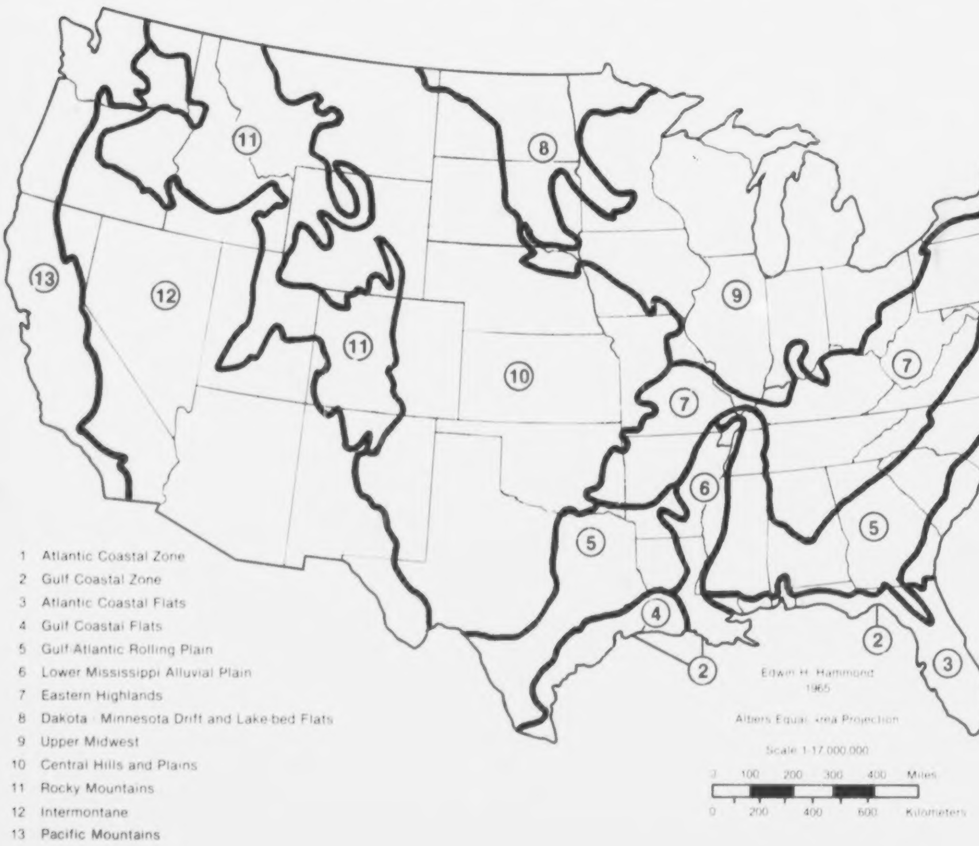
The various wetland types described in the previous section are distributed unevenly across the United States. The regions of the United States with high concentrations of the various types are identified in table 3. The regions described are based on Hammond's Physical Subdivisions (fig. 3), which are the same as those used in *Chapter 5: Wetland Trends.*

**Table 3.—Locations of Various Wetland Types in the United States**

| Wetland type | Primary regions | States |
|---|---|---|
| Inland freshwater marsh | Dakota-Minnesota drift and lake bed (8); Upper Midwest (9); and Gulf Coastal Flats (4) | North Dakota, South Dakota, Nebraska, Minnesota, Florida |
| Inland saline marshes | Intermontane (12); Pacific Mountains (13) | Oregon, Nevada, Utah, California |
| Bogs | Upper Midwest (9); Gulf-Atlantic Rolling Plain (5); Gulf Coastal Flat (4); and Atlantic Coastal Flats (3) | Wisconsin, Minnesota, Michigan, Maine, Florida, North Carolina |
| Tundra | Central Highland and Basin; Arctic Lowland; and Pacific Mountains | Alaska |
| Shrub swamps | Upper Midwest (9); Gulf Coastal Flats (4) | Minnesota, Wisconsin, Michigan, Florida, Georgia, South Carolina, North Carolina, Louisiana |
| Wooded swamps | Upper Midwest (9); Gulf Coastal Flats (4); Atlantic Coastal Flats (3); and Lower Mississippi Alluvial Plain (6) | Minnesota, Wisconsin, Michigan, Florida, Georgia, South Carolina, North Carolina, Louisiana |
| Bottom land hardwood | Lower Mississippi Alluvial Plain (6); Atlantic Coastal Flats (3); Gulf-Atlantic Rolling Plain (5); and Gulf Coastal Flats (4) | Louisiana, Mississippi, Arkansas, Missouri, Tennessee, Alabama, Florida, Georgia, South Carolina, North Carolina, Texas |
| Coastal salt marshes | Atlantic Coastal Zone (1); Gulf Coastal Zone (2); Eastern Highlands (7); Pacific Moutains (13) | All Coastal States, but particularly the Mid- and South Atlantic and Gulf Coast States |
| Mangrove swamps | Gulf Coastal Zone (2) | Florida and Louisiana |
| Tidal freshwater wetlands | Atlantic Coastal Zone (1) and Flats (3); Gulf Coastal Zone (2) and Flats (4) | Louisiana, Texas, North Carolina, Virginia, Maryland, Delaware, New Jersey, Georgia, South Carolina |

SOURCE: This table is based on maps from Samuel P. Shaw and C. Gordon Fredine, "Wetlands of the United States: Their Extent and Their Value to Waterfowl and Other Wildlife," Fish and Wildlife Service, U.S. Department of the Interior, Circular 39, 1956.

**Figure 3.—Physical Subdivisions**


1 Atlantic Coastal Zone
2 Gulf Coastal Zone
3 Atlantic Coastal Flats
4 Gulf Coastal Flats
5 Gulf-Atlantic Rolling Plain
6 Lower Mississippi Alluvial Plain
7 Eastern Highlands
8 Dakota · Minnesota Drift and Lake-bed Flats
9 Upper Midwest
10 Central Hills and Plains
11 Rocky Mountains
12 Intermontane
13 Pacific Mountains
Edwin H. Hammond
1965
Albers Equal Area Projection
Scale 1:17,000,000
0 100 200 300 400 Miles
0 200 400 600 Kilometers

# CHAPTER 2 REFERENCES

1. Brown, Sandra, Brinson, Mark M., and Lugo, Ariel E., "Structure and Function of Riparian Wetlands," *Strategies for Protection and Management of Floodplain Wetlands and Other Riparian Ecosystems,* proceedings of a symposium sponsored by the U.S. Forest Service, in Callaway Gardens, N.J., Dec. 11-13, 1978.
2. Clark, J. R., "Coastal Ecosystem Management" (New York: John Wiley & Sons, Inc., 1970), pp. 660-665.
3. Council on Environmental Quality, "Our Nation's Wetlands," an Interagency Task Force Report, 1978, p. 70.
4. Frederickson, L. H., "Lowland Hardwood Wetlands: Current Status and Habitat Values for Wildlife," *Wetland Functions and Values: The State of Our Understanding,* proceedings of the National Symposium on Wetlands, P. E. Greesen, J. R. Clark, and J. E. Clark (eds.), Nov. 7-10, 1978.
5. Johnson, Roy R., "The Lower Colorado River: A Western System," *Strategies for Protection and Management of Floodplain Wetlands and Other Riparian Ecosystems,* proceedings of a symposium sponsored by the U.S. Forest Service, in Callaway Gardens, N.J., Dec. 11-13, 1978.
6. Kusler, J., "Our Wetland Heritage: A Protection Guidebook" (Washington, D.C.: Environmental Law Institute, 1983).
7. National Wetlands Technical Council, Workshop Report on Bottomland Hardwood Wetlands, held at Lake Lanier, Ga., June 1-5, 1980.
8. National Wetlands Technical Council, "Scientists'

Report," *National Symposium on Wetlands*, Lake Buena Vista, Fla., Nov. 6-9, 1978, p. 32.

9. New England/Massachusetts Case Study, OTA contractor: Water Resources Research Center, University of Massachusetts, Amherst, 1983.
10. Odum, E. P., *Fundamentals of Ecology*, 3d ed. (Philadelphia: W. B. Saunders Co., 1971), pp. 380-383.
11. Odum, W. E., Dunn, M. L., and Smith, T. J., III, "Habitat Value of Tidal Freshwater Wetlands," *Wetland Functions and Values: The State of Our Understanding*, proceedings of the National Symposium on Wetlands, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.), Nov. 7-10, 1978.
12. Odum, H. T., Copeland, B. J., and McMahan, E. A. (eds.), *Coastal Ecological Systems of the United States*, vol. 2 (Washington, D.C.: The Conservation Foundation, 1974).
13. Shaw, Samuel P., and Fredine, C. Gordon, "Wetlands of the United States: Their Extent and Their Value to Waterfowl and Other Wildlife," Fish and Wildlife Service, U.S. Department of the Interior, Circular 39, 1956.

## Chapter 3

# Wetland Values and the Importance of Wetlands to Man

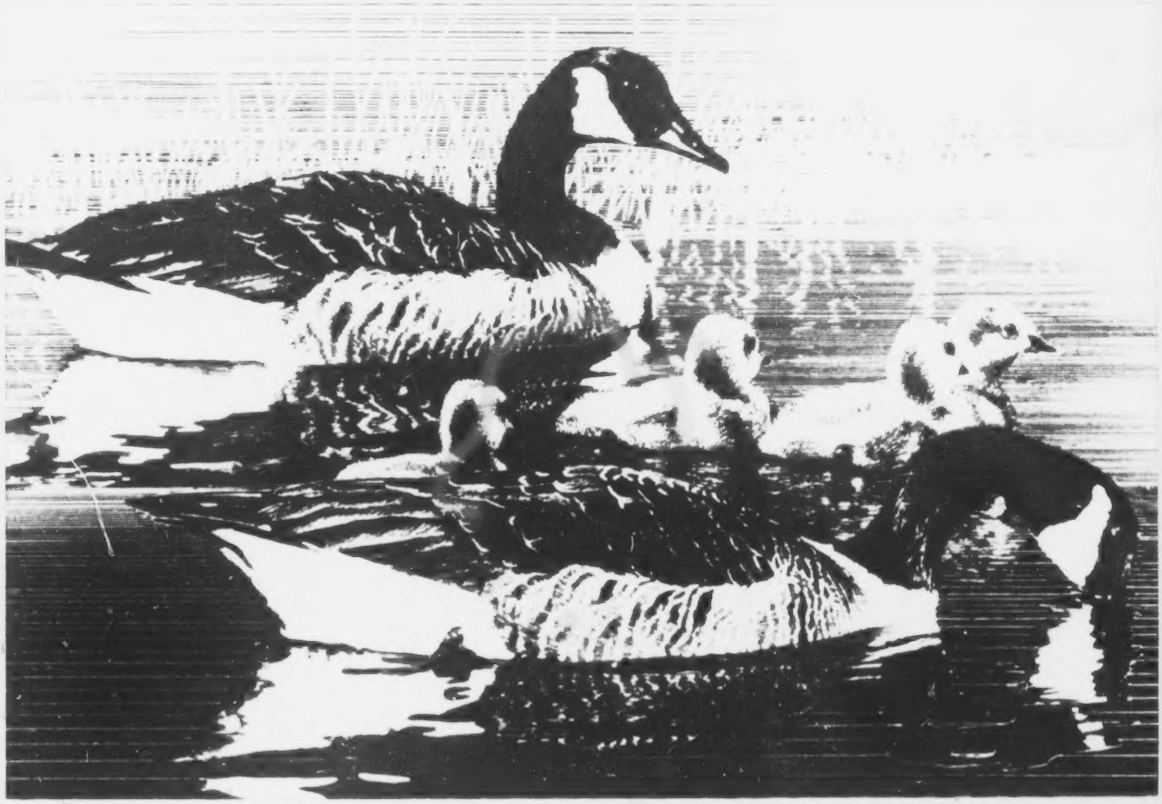


*Illustration credit: U.S. Fish and Wildlife Service, Alderson Magee*

# Contents

Page

**Chapter Summary** ... 37

**Attitudes Toward Wetlands** ... 37

**Intrinsic Values of Wetlands** ... 39
Wetlands as Natural Areas ... 39
Wetlands for Recreation and Education ... 41
Other Intrinsic Values ... 42

**Ecological Services or Resource Values of Wetlands** ... 43
Floodpeak Reduction ... 43
Shoreline Erosion Control ... 46
Ground Water Recharge ... 47
Water Quality Improvement ... 48
Fish and Wildlife Values ... 52
Climatic and Atmospheric Functions ... 60

**Chapter 3 References** ... 61

## TABLES

*Table No.* Page
4. Summary of Input-Output Studies ... 51
5. Selected ~~Commercial or~~ Sport Fish and Shellfish Utilizing Coastal Marshes as Nurseries ... 56
6. Endangered Wetland Species on the Federal Endangered and Threatened Species List ... 57
7. Game and Fur Animals Identified by State Game Managers as Found in Wetlands ... 58
8. The 10 Most Recreationally Important Marine Fish in the United States in 1979 Ranked by Number of Fish Landed ... 58
9. The 15 Most Important Fish and Shellfish Harvested by U.S. Fisheries in 1980 ... 59
10. Wetland Plant Productivity ... 59

## FIGURES

*Figure No.* Page
4. Relationship Between Wetland Processes and Values ... 44
5. General Pattern of Duck Distribution in North America ... 53

## Chapter 3

# Wetland Values and the Importance of Wetlands to Man

## CHAPTER SUMMARY

Some people value wetlands for their *intrinsic qualities*. They may wish to protect wetlands simply out of a desire to preserve natural areas for future generations or because they are often the last areas to be developed. Others value the varied and abundant flora and fauna that may be found in wetlands, and the opportunities for hunting, fishing, and boating and other recreational activities. While these recreational benefits can be quantified to some extent, the other intrinsic values of wetlands are, for the most part, intangible. For this reason, the justification for protecting wetlands has often focused on the importance of the *ecological services* or resource values that wetlands provide, which are more scientifically and economically demonstrable than intrinsic qualities. These ecological services include floodpeak reduction, ground water recharge, water quality improvement, food and habitat, food-chain support, and shoreline stabilization.

The intrinsic values and ecological services provided by wetlands can vary significantly from one wetland to another and from one region of the country to another. Some wetlands provide benefits that primarily are local or regional in nature; other benefits may be national or even international in scope. *Because of the wide variation among individual wetlands, the significance of their ecological services and intrinsic values must be determined on an individual or regional basis.*

The dollar value of the ecological services that wetlands provide sometimes can be quantified. The U.S. Army Corps of Engineers, for instance, estimated that the loss of the entire 8,422 acres of wetlands within the Charles River Basin, Mass., would produce average annual flood damage of over $17 million. However, because the many intrinsic qualities of wetlands cannot be quantified, it is difficult to place generally accepted dollar values on wetlands.

## ATTITUDES TOWARD WETLANDS

The use of wetlands has become a public policy issue because of conflicts between those who wish to develop them and those who wish to preserve them. Developers, for instance, regard wetlands as prime locations for development because of their typical proximity to open water. Farmers drain or clear wetlands to plant crops in their rich organic soil. While there also are private gains involved, the creation of new jobs or the production of food that results from the development of wetlands directly benefits society.

On the other hand, undeveloped wetlands have important intrinsic qualities that are esthetically pleasing and provide numerous ecological services, such as flood control, that benefit society. The conflict between developers and conservationists over wetlands often is viewed as an issue that ''involves questions of public good as opposed to private gain'' (21). However, the issue is not simply a matter of public versus private interests but of conflicting public interests.

The values associated with wetlands were not always widely recognized. For example, in the 19th century when a national priority was placed on settling the country, wetlands were considered a menace, the cause of malaria, and a hindrance to land development. Through the Swamp Land Acts of 1849, 1850, and 1860, Congress granted to States all swamps and overflow lands for reclamation to reduce the destruction caused by flooding and eliminate mosquito-breeding swamps. A total of 65 million acres of wetlands were granted to 15 States for reclamation (81).

With increasing concerns about preserving different ecosystems, the public's perception of and attitude toward wetlands has changed gradually over the last half century. An inventory of wetlands conducted by the U.S. Fish and Wildlife Service (FWS) in the mid-1950's perhaps did the most to change attitudes about wetlands over the past three decades (81). The introduction to the inventory stated: "So long as this belief prevails (that wetlands are wastelands), wetlands will continue to be drained, filled, diked, impounded, or otherwise altered, and thus will lose their identity as wetlands and their value as wildlife habitat." The inventory created the lasting perception that wetlands rapidly were disappearing—a perception that galvanized certain groups to preserve wetlands.

Since the *intrinsic values*—recreation and a sense of the need to preserve the unique flora and fauna of scenic, natural areas—that motivated wetland protection at the outset were not appreciated universally, proponents began to investigate more tangible, *ecological services* provided by wetlands. Initially, these other services were suggested in the FWS wetland inventory report:

> . . . the storage of ground water, the retention of surface water for farm uses, the stabilization of runoff, the reduction or prevention of erosion, the production of timber, the creation of firebreaks, the provision of an outdoor laboratory for students and scientists, and the production of cash crops, such as minnows (for bait), marsh hay, wild rice, blackberries, cranberries and peat moss (81).

In his 1977 environmental message, President Carter conveyed an attitude about wetlands that stood in sharp contrast to the attitude of the early 1900's:

> The Nation's coastal and inland wetlands are vital natural resources of critical importance to the people of this country. Wetlands are areas of great natural productivity, hydrological utility, and environmental diversity, providing natural flood control, improved water quality, recharge of aquifers, flow stabilization of streams and rivers, and habitat for fish and wildlife resources. Wetlands contribute to the production of agricultural products and timber and provide recreational, scientific, and esthetic resources of national interest.[1]

Knowledge of the importance of the ecological services provided by wetlands has increased steadily, especially over the past two decades. As wetlands research continues, knowledge about the values of individual and different types of wetlands will, in all likelihood, improve. For example, some wetland services, such as ground water recharge, have been found to be less significant than once thought. On the other hand, the ecological services of inland freshwater wetlands with the exception of wildlife habitat are not widely recognized by the general public. It is quite possible that some wetlands may provide ecological services that are as yet unknown or poorly documented. In addition, the overall significance of continuing, incremental losses of wetlands is well known only in a few cases. Waterfowl managers, for example, use the number of prairie potholes in the Midwest to predict fall duck populations; without these wetlands, North American duck populations would decrease by about half. On the other hand, the importance of wetland-derived detritus for estuarine fish and shellfish populations relative to other sources of food, such as algae and detritus from upland areas, is not well known. Future research may resolve many of these uncertainties.

---

[1] Statement by the President accompanying Executive Order 11990; 42 FR 26961 (1977).

# INTRINSIC VALUES OF WETLANDS

In recent years, the case for preserving wetlands has been based more and more on the ecological services provided by wetlands[2] and on the availability of scientific evidence documenting these services. For example, in a recent paper, William Reilly stated:

> Every bit of evidence that does exist suggests that our interior wetlands are vital elements of national estate. But there are many challenging voices—questioning voices. These will become stronger in future years. They will demand to be shown the scientific evidence behind wetland conservation decisions (81).

This situation perhaps has obscured one fundamental motivation of some for preserving wetlands—the desire to preserve, intact and unspoiled, unique natural ecosystems. For many personal reasons, whether ethical, religious, esthetic, or recreational in nature, people value wetlands for their intrinsic qualities. Because these intrinsic values are intangible and thus difficult to express in quantitative and economic terms, they are often overlooked in a society where decisions are based on numerical cost-benefit analyses. Although there have been attempts to quantify these values, this discussion simply identifies those characteristics of wetlands that people value.

## *Wetlands as Natural Areas*

Some people are attracted to an environment that essentially is untouched by man's presence,[3] which is an attraction akin to the lure of wilderness. One scientist, for instance, writes in the preface to a wetland study:

> The river swamps are, for many of us in the Southeast, the last wilderness. True, they are narrow, even the mighty Altamaha swamp scarcely exceeds 5 miles in width; yet in length they are large indeed, often stretching more than half the length of the state. Narrow as they are, many provide a true wilderness experience. Where else in this mechanized, modern world can we so quickly lose ourselves in wildness without evidence of the massive civilization that surrounds us? (97).

Part of the reason that marshes, swamps, bogs, and other wetlands are associated with natural, undisturbed environments is that they are often the last areas to be developed. The difficulty and expense of draining wetlands for development have encouraged people to develop other areas first.

Various studies have found that wetlands rank high in esthetic quality in comparison to other landscape types (82). One particular value of wetlands is the attraction of the land-water interface. Many people find the edge between land and sea, lake, or stream scenically appealing, and such areas often include wetlands as well as beaches and banks. Small wetlands are capable of being surveyed in a glance or traversed in a few minutes and offer a contrast to the adjoining land or water. Seen from a passing car or hiking trail, wetland edges buffer commercially or agriculturally developed lands, providing scenic variety. Small wetlands also contrast with other types of natural areas, such as upland forests or open water.

Large wetlands have a similar "variety" value along their edges but may have other esthetic attributes as well. Of all natural areas, the most mysterious and haunting in appearance are the large cypress swamps draped with Spanish moss. Less exotic are wooded swamps, which are full of different shapes, textures, plants, and animals. Access and visibility are important factors; for example, pleasing wooded swamps should not be choked with underbrush that greatly impedes passage by foot or canoe. A large, open, grassy marsh can present quite an esthetic contrast and a feeling of open space.

In addition to the esthetic qualities of wetlands themselves, wetland flora and fauna lend a special esthetic attraction to wetlands. Waterbirds are a good example: herons, egrets, storks, terns, pelicans, and cranes all are found commonly or pri-

---

[2] Massachusetts, for instance, the first State to enact a wetland law, recognizes seven wetland values: flood control, prevention of pollution, prevention of storm damage, protection of the public and private drinking water supply, protection of ground water supply, protection of fisheries 1978-79; Act of Mar. 25, 1965; ch. 220, 1965; Massachusetts Acts 116; Act of May 22, 1963; ch. 426, 1963; Massachusetts Acts 240.

[3] In the following discussion, examples illustrating these characteristics of wetlands are presented. Unless otherwise noted, these examples are taken from J. Perry and J. G. Perry, *Guide to Natural Areas of the Eastern United States* (New York: Random House Publishers).

*Photo credit: U.S. Fish and Wildlife Service, C. Kenneth Dodd, Jr.*

Draped with Spanish moss, the haunting Santee-Cooper River Swamp in South Carolina provides an uncommon wilderness experience

*Photo credit: U.S. Fish and Wildlife Service*

A number of distinctive and unusual plants grow in wetlands. Five genera of insectivorous plants, for instance, including this Venus fly trap, are found in North Carolina pocosins

marily in wetland habitats. Other species are more unusual. Five genera of insectivorous plants can be found in a North Carolina pocosin, including round-leaved sundew, butterworts, Venus fly traps, bladderworts, and two species of pitcher plants. In addition, wetlands, particularly those whose origins were glacial, often provide habitat for "relict" plants and animals, that is, those that were once, but are no longer, endemic to an area. Cranesville Swamp in West Virginia has a number of relict species, including Tamarack, Swainson's, and hermit thrushes; Nashville and mourning warblers; and purple finch, that typically are found much farther north.

Overall, wetlands are characterized by many different kinds of flora and fauna relative to other ecosystems. For example, approximately 5,000 species of plants, 190 species of amphibians, and approximately one-third of all bird species are thought to occur in wetlands across the United States (18, 22,45). A single, freshwater tidal marsh may have from 20 to 50 plant species. Over 100 woody plant species may inhabit bottom lands. (19). This diversity of plant types creates, in turn, a diversity of habitats for animals. Living in the Okefenokee Swamp in Georgia are over 200 species of birds, 41 species of mammals, 54 species of amphibians and reptiles, and all duck species found along the Atlantic flyway. In the Bombay Hook National Wildlife Refuge in Delaware, an area of 12,000 acres of brackish tidal marsh, over 300 bird species have been recorded. Tinicum Marsh, a national environmental education center outside of Philadelphia, has more than 300 plant species and over 250 bird species.

In addition to the many different kinds of flora and fauna, abundant populations of wildlife, especially waterfowl and waterbirds, make wetlands even more attractive as natural areas. The Merrit Island National Wildlife Refuge in Florida, an area with over 34,000 acres of freshwater and saltwater marshes and swamps, has a wintering waterfowl population of nearly 70,000 ducks and 120,000 coots. Hundreds of thousands of robins arrive at the Okefenokee Swamp each year. Mass nestings of wood storks—as many as 6,000 pairs—occur at the Corkscrew Swamp Sanctuary in Florida.

## Wetlands for Recreation and Education

Wetlands provide direct enjoyment to inhabitants, visitors, and passers-by in many ways. Recreational activities in or around wetlands, including hiking, boating, fishing, hunting, and the observation of wildlife are pursued by millions of people and amount to billions of dollars in expenditures each year. For example, 19 of the 25 most visited National Wildlife Refuges (out of 309 refuge

Photo credit: U.S. Fish and Wildlife service, Lawrence S. Smith

A Youth Conservation Corps group is instructed in marsh ecology at a National Wildlife Refuge. Environmental education is a major theme in many parks and public areas established around wetland areas units) have substantial wetland components (90). These 19 refuges represent approximately 50 percent of the total visitation to all U.S. National Wildlife Refuge units. Several of these refuges are predominantly wetland environments: J. N. Ding Darling Refuge in Florida, considered one of the best birdwatching sites in the United States, had 671,000 visitors in 1981 (8th overall); Loxahatchee Refuge in Florida had 333,329 visitors (19th); Okefenokee Refuge, one of the oldest, largest, and wildest swamps in the United States, had 257,927 visitors (21st); the Great Swamp Refuge, more than half of which is wilderness within the New York City Metropolitan Area, had 250,756 visitors (23d). Recreational use of the Everglades National Park in Florida averaged 675,000 from 1979 to 1981 (60).

Wetlands also may provide learning opportunities for the general public or sites for educational and scientific purposes. Research on such subjects as botany, ornithology, and anthropology frequently is carried out in wetland areas. Environmental education is a major theme in many parks and public areas established around wetlands. For example, the environmental center at Tinicum Marsh on the outskirts of Philadelphia coordinates numerous public education programs. In 1981 it had 32,730 visitors (60).

From a purely scientific standpoint, the concept of the ecosystem has played an important role in environmental research and in the formal teaching of ecology. Because of the importance of water to the biosphere, most ecosystem study areas are selected to include water bodies such as streams, lakes, and wetlands. Wharton, (97) for instance, describes the scientific opportunities available through the Alcovy River Swamp:

> The Alcovy River is ideally suited for educational uses: it is essentially unpolluted, it is located within easy driving distance of a large metropolitan area but is unaffected by it; and it contains a unique swamp ecosystem found nowhere else in the Georgia Piedmont.
>
> The river swamp has a diversity of habitats and a corresponding diversity of plants and animals. It offers aquatic communities of all types of water, both flowing and still. The periodically high biomass of certain plant and animal groups offers an approach to community ecology and productivity. The drying up of bodies of water imitates both Paleozoic and monsoonal climatic effects on life and can illustrate the evolutionary transition from water to land. The swamp shows rapid changes in physiochemical conditions.
>
> The yearly import of decomposed mineral matter can involve both geological and cultural (agricultural) concepts. The processes of photosynthesis and decomposition can be readily demonstrated. Both the aquatic and the terrestrial segments of this ecosystem are subject to an annual series of plant and animal communities (succession), rapidly enforced by the regimen of the hydrocycle. Invertebrates such as clams, snails, leeches, adult aquatic insects, and larvae of aerial forms are extremely abundant—some of the species are "indicators" of the degree of pollution present.
>
> Much of the swamp fauna (invertebrates, fish, salamanders, mammals, birds) are present in midwinter, when other habitats are barren. Many of the vertebrate groups are yearly renewable by inundation (fish), are fossorial (salmanders), or are extremely plentiful (frogs). Thus, the animal community is not easily damaged or overcollected. There are few subsurface runways to crush, or delicate layers of litter and humus to compress, as in a terrestrial forest. Most of the mammals are renewable by migration from the river corridor if accidentally killed; the tracks, droppings, or other evidence of most are readily observable on the bare swamp floor (raccoon, otter, mink, wildcat, beaver, rodents, shrews). The ecosystem is adjusted to what might be called "annual catastrophism." Even the forest floor is changed and renewed to some extent annually.

## *Other Intrinsic Values*

In addition to those values previously discussed, there may be other less obvious but just as important reasons for preserving natural areas, including wetlands (28). Many plants and animals may have great potential resource value for food, chemicals, drugs, and so forth, but are as yet undiscovered or undeveloped. Some scientists believe that all species are an integral part of the natural environment and contribute in some, perhaps unknown, way to its natural order and stability. The conservative belief is that excessive manmade impact on this natural system could cause irreversible changes in the natural order of the environment that may carry an unknown risk of serious damage to humans and their civilization. Natural systems can provide baseline conditions that help determine the extent to which the environment has been affected by man's activities and pollution. They may provide models for restoring or replacing habitats that have been significantly affected or even models of long-term survival for redesigning greatly modified, man-dominated systems that typically have not worked reliably over long periods of time.

Many people believe that unaltered natural areas, including wetlands, are valuable in and of themselves, regardless of any tangible benefits or ecological services society may receive from them. The reassurance that wetlands and other types of natural areas exist for both present and future generations can be a strong motivation to preserve wetlands in an undisturbed state. The Nature Conservancy, an organization whose goal is "the preservation of natural diversity by protecting lands containing the best examples of all components of the natural world," has devoted 50 percent of its past preservation efforts to the protection of wetlands. In the future, it plans to expand this to approximately 75 percent (53). Similarly, the North Carolina Natural Heritage Program gives top priority to protection of Carolina bays (bog swamps), bottom land swamps, and peat bogs (80). Under the South Carolina Heritage Trust Program, 60 percent of the areas preserved are shallow impoundments, marshes, flood plains, and wetland depressions (80). In the Wisconsin Scientific Areas Program, which inventories unique natural areas, approximately 50 percent of all inventoried areas are wetlands (36).

# ECOLOGICAL SERVICES OR RESOURCE VALUES OF WETLANDS

The interaction between the hydrologic regime and the wetland topography, saturated soil, and emergent vegetation largely controls the general characteristics and the significance of the processes that occur in wetlands. The *processes* are in turn responsible for the *ecological services* the wetland may perform (fig. 4).

Isolated wetlands may *temporarily store runoff,* and flood plain wetlands may provide additional conveyance capacity for flood waters, thereby reducing floodpeaks in downstream areas. During periods of inundation, water flows over and through the wetland, depositing nutrient-rich organic and inorganic material suspended in the water. This *suspended material is "trapped"* along with any toxic materials that may be bound onto this suspended material. The nutrients and their substances thus become involved in many complex *biochemical cycles* within the wetland system. These nutrients help fuel the relatively *high plant productivity* characteristic of most wetlands during the growing season. The leaves of plants provide food and habitat for many forms of wildlife and endangered species during the growing season. At the end of the growing season, when the vegetation dies back, some of the leaf material remains in the wetland to support future plant growth in the coming season. Other leaf material is flushed into adjacent water bodies where it provides a nutrient-rich source of food for many aquatic organisms in the food chain. The *plant roots anchor* the wetland soils and prevent their erosion in some flood plain and coastal environments. The ecological services of wetlands are described in more detail below.[4]

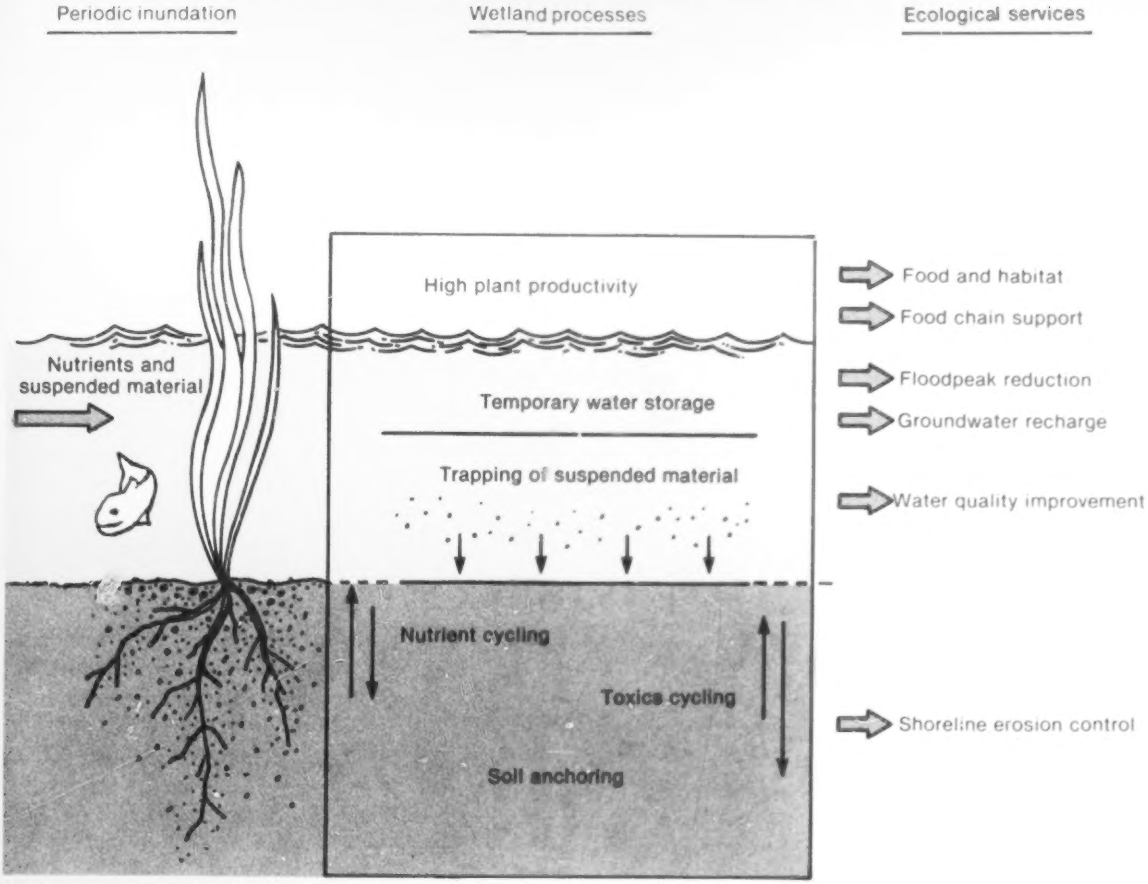
## *Floodpeak Reduction*

The ability of wetlands to store and convey floodwater is primarily a function of their topography. Many isolated freshwater and river wetlands are

---

[4] Recent reviews of the scientific literature have been completed by: 1) P. R. Adamus and L. T. Stockwell, "A Method for Wetland Functional Assessment," U.S. Department of Transportation, Federal Highway Administration, Office of Research, Environmental Division, Washington, D.C., 1983, p. 176; and 2) J. H. Sather and R. P. Smith, "An Overview of Major Wetland Functions," U.S. Fish and Wildlife Service, Washington, D.C., 1983.

Figure 4.—Relationship Between Wetland Processes and Values


Periodic inundation
Wetland processes
Ecological services
High plant productivity
Nutrients and suspended material
Temporary water storage
Trapping of suspended material
Nutrient cycling
Toxics cycling
Soil anchoring
Food and habitat
Food chain support
Floodpeak reduction
Groundwater recharge
Water quality improvement
Shoreline erosion control

SOURCE: Office of Technology Assessment.

topographic depressions that retain runoff flowing into them, at least until they are full. Also, during flooding, the river overflows its banks and spreads laterally across the flood plain, increasing its cross-sectional area and conveyance capacity. By temporarily storing storm water and providing capacity to convey floodwaters, wetlands can reduce floodpeaks and the frequency of flooding in downstream areas. Vegetation in flood plain wetlands further reduces the flow velocity of the river, thereby reducing potential floodpeaks in downstream areas and riverbank erosion. If the soil in a wetland is unsaturated, the soil itself will provide some storage capacity during periods of flooding. While the value of some wetlands for flood storage and conveyance is well known, analytical techniques for predicting the magnitude of this service still are being developed. The value of inland wetlands to reduce flooding in downstream areas generally depends on the area of the wetland, its location downstream, the magnitude of flooding, and the degree of encroachment on the wetland (16,31,67,88).

### Inflow-Outflow Measurements

Only two studies were found that actually determined the storage capacity of a wetland during flood conditions. One study measured water levels of a cypress-tupelo swamp adjacent to the Cache River in southern Illinois before and after flooding to calculate the amount of flood water storage. The 90-acre swamp, which is separated from the river by a natural levee, stored 80,131 cubic meters ($m^3$) of water. If this amount of storage were extrapolated to the entire area of swampland in the watershed, total wetland storage would equal 8.4 percent of the total flood runoff as measured at a downstream gage (52).

Bernot found that flow was about 5,000 cubic feet per second ($ft^3/s$) into the Thief Run Wildlife Management Area and the Agassiz National Wildlife Refuge, while outflow was approximately 1,400 $ft^3/s$. He calculated that the flood storage capacity and losses due to the other factors of these two wetland areas reduced the floodpeak at Grand Forks, by about 0.5 foot and at Crookston by about 1.5 feet (8).

### Comparison of Floodpeaks From Wetland and Nonwetland Watersheds

By studying floodpeaks in 15 watersheds, Novitzki found that floodpeaks may be as much as 80 percent lower in watersheds with large lake and wetland areas than in similar basins with little or none. Watersheds with 40-percent lake and wetland area have floodpeaks only 20 percent as large as those with little or no wetland area. While floodpeaks were found to be lower in watersheds with a large percentage of wetlands, *total* streamflow in the spring was higher in basins with large lake and wetland areas (63).

### Analysis of Flood Hydrographs

Flood hydrographs—graphs of the time distribution of runoff from a drainage basin—of perched peat bogs and peatlands indicate that these wetlands temporarily store and slowly release storm waters (5,9). Long-term hydrographs from the Passaic River, N.J., and the Ipswich River, Mass., showed that the wetlands adjacent to the rivers play an important role in delaying runoff (31). Synthetic hydrographs (not calculated on historical data) for eight wetland areas also showed reductions in peak flows (94).

Actual flood-storage capacity often will depend on environmental conditions prior to flooding or on the relationship of a particular wetland to the regional hydrology. For example, when evapotranspiration rates are low and water is ponded in wetlands, runoff during periods of heavy precipitation may be greater from wetlands than from upland areas (because the soil is saturated and the surface storage capacity quickly is exceeded) (51,77, 92). On the other hand, high rates of evapotranspiration and low water tables favor storage of floodwaters. In some cases, wetlands provide no storage capacity for floodwaters. For example, a hydrographic analysis of two Massachusetts swamps indicated that both wetlands contributed significantly to floodpeaks because of their rapid discharge of ground water (64).

### The Role of Vegetation in Flooding

There have been a few attempts to isolate the effect of vegetation on flooding. The frictional drag on runoff flowing through wetland vegetation is represented by a roughness coefficient called "Manning's 'n.' " The higher the value of "n," the greater the drag and the slower the flow velocity of floodwaters. Values of "n" vary widely and are highly dependent on the type and amount of vegetative cover. In general, the value of "n" for a river wetlands in or adjacent to it can be approximately twice the value of channels without associated wetlands (15).

### Impact of Wetland Filling and Development on Flooding

The Corps has used model-generated hydrographs to estimate the volume of storm water that could be stored in the basin wetlands of the Charles River, Mass., and to determine the reduction in storage, assuming future encroachment (89). Following a storm in 1955, approximately 50,000 acre-ft of storm water flushed past the Charles River Village gaging station with a peak flow of 3,220 $ft^3/s$. This amount is equivalent to 5 inches of runoff from the 184-square-mile drainage basin. On the adjacent Blackstone River, which has few, if any, wetlands, the storm discharge peaked at 16,900 $ft^3/s$ and the bulk of the storm water was discharged in a much shorter time period than on the Charles. Based on this analysis, it was predicted that a 40-percent reduction in wetland area along the river would result in a 2- to 4-foot increase in floodpeaks and would increase flood damages by at least $3 million annually.

Hydrographs of the Neponset River Basin, Mass., were used to determine the impact of encroaching on the basin's flood plains and wetlands (1). The study predicted that the basinwide flood level for the 100-year flood would increase 0.5 feet if 10 percent of the flood plain/wetland storage capacity were lost, and 3 feet if 50 percent of the flood plain/wetland storage capacity were lost. Filling a wetland will reduce its storage capacity; if the fill material rises above the level of the flood plain, flood conveyance value also may be reduced.

The effects of drainage on floodflows are slightly more complicated. One point of view is that drainage increases floodpeaks by synchronizing and speeding the runoff of water and by eliminating the potential storage of runoff in wetlands. A contrasting viewpoint is that drainage channels may reduce floodpeaks by draining away heavy rains that otherwise would have left the soil saturated through the winter, reducing the storage available during critical spring rain and snowmelt. Research to date has not yet resolved this controversy.[5]

## *Shoreline Erosion Control*

Shoreline erosion is a natural process caused by river currents during flooding, tidal currents in the coastal areas, and wind-generated waves along the shores of large lakes, broad estuaries, and ocean-facing barrier islands. Boat wakes also can cause considerable shoreline damage.

Four characteristics of *vegetated* wetlands are responsible for reducing erosion: 1) the low-gradient shore that absorbs and dissipates wave energy (70); 2) the dampening and absorption of wave energy by the plants themselves (44,95); 3) the root structure and peat development in wetlands that bind and stabilize the shore (71,76); and 4) the deposition of suspended sediment that is encouraged by dense growth of wetland plants.[6]

Vegetated freshwater or saltwater wetlands located adjacent to open but usually sheltered bodies of water significantly reduce shoreline erosion caused by large waves generated by occasional storms and boat traffic.[7] Wetlands adjacent to rivers also may reduce riverbank erosion from strong currents during major flooding. Although it generally is agreed that wetland vegetation does not naturally establish itself in high-energy environments where the potential for erosion is greatest, wetland plants, once established, do help to control erosion, stabilize the soil, encourage deposition of sediments, and dampen wave energy. Isolated wetlands not associated with larger bodies of water will not have significant value for erosion control.

### Potential Economic Importance

Shoreline erosion is a major problem in many coastal areas. In Virginia, for instance, it has been estimated that 1,476 hectares of tidal shoreline eroded away between 1850 and 1950. This amount represents approximately 20 percent of the 5 million metric tons of silt and clay that wash into Virginia's estuaries annually (39). The impacts of shoreline erosion include: loss of public and private property and the subsequent loss of taxable income for localities, filling of navigable waters with eroded sediment, increased turbidity of waters, siltation of fish and wildlife habitat, and loss of recreationally valuable sand beaches. Millions of dollars are spent each year to reduce shoreline erosion and maintain the navigability of channels.

### Ability of Wetlands to Control Shoreline Erosion

Wetlands not only resist erosion themselves, but also protect the more easily eroded upland areas shoreward of the wetland. Three studies have compared the rate of erosion of uplands buffered by wetlands to that of unbuffered uplands.

---

[5] See the following references for reviews of information pertaining to the impacts of wetlands draining on flooding: 1) L. J. Brunn, J. L. Richardson, J. W. Enz, and J. K. Larsen, "Streamflow Changes in the Southern Red River Valley of North Dakota," *North Dakota Farm Research Bimonthly Bulletin*, vol. 38, No. 5, 1981, pp. 11-14; 2) John M. Malcolm, "The Relationship of Wetland Drainage to Flooding and Water Quality Problems and Its Impact on the J. Clark Salyer National Wildlife Refuge," FWS, Upham, N. Dak., 1979; and 3) J. E. Miller and D. L. Frink, "Changes in Flood Response of the Red River of the North Basin, North Dakota-Minnesota," U.S. Geological Survey, Open File Report 82-774, 1982.

[6] Recent reviews of the scientific literature have been completed by P. R. Adamus and L. T. Stockwell, "A Method for Wetland Functional Assessment," U.S. Department of Transportation, Federal Highway Administration, Office of Research, Environmental Division, Washington, D.C., 1983, p. 176.

[7] Most of the existing literature on this function has been reviewed in the following: 1) H. H. Allen, "Role of Wetland Plants in Erosion Control of Riparian Shorelines," *Wetlands Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 403-414; 2) Carter, et al. (15); 3) R. G. Dean, "Effects of Vegetation on Shoreline Erosional Processes," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 415-426; and 4) Institute for Water Resources (88).

In a study of two similar sites on the Hackensack River in New Jersey, the marsh vegetation at one site was cut; at the other site, the marsh was left in its natural condition (26). Both sites were subjected to waves generated by heavy boat traffic. While the uncut site exhibited only a negligible retreat of the bank over the year of monitoring, the bank at the second site retreated nearly 2 meters, with most of the change occurring immediately after the marsh was cut.

In a second study, the rate of erosion of upland areas at three sites on the Chesapeake Bay over a 20-year period was measured with aerial photographs. Wetlands eroded as fast as adjacent uplands; however, erosion of uplands buffered by the wetlands was negligible (70).

In a third study the retreat/advance of the shorelines of an artificially planted marsh *(Juncus roemerianus, Phragmites australis, Typha latifolia,* and *Spartina alterniflora)* and of an adjacent unplanted area were measured over a period of 8 years (7). Initial erosion of the planted area was followed by a period when the shoreline actively expanded before it appeared to reach equilibrium. In general, the volume of sediment eroded from the unplanted shore averaged 2.3 $m^3$ per lineal meter-year ($m^3$/lineal m-yr.), nearly four times the average rate observed in the planted marsh. In addition, the unplanted shore retreated at a rate that was more than twice that observed for the marsh-fringed shore.

### Limitations of Wetlands to Control Erosion

Natural wetlands are typically found in low-energy environments, sheltered from extensive wave action (4,17). Artificial wetlands, however, often are constructed in higher wave-energy environments where natural wetlands would not typically occur. Young rooted plants are used rather than allowing the shoreline to seed itself naturally. In addition, with many artificial plantings, a "toe" or low ridge is constructed below the marsh to contain the marsh soil and to reduce the impact of incoming waves until the plants are established firmly. Most of the literature citing the erosion-control functions of wetlands is based on observations of marshes specifically planted to control erosion. For example, in a 1981 survey of 86 marshes planted to control shoreline erosion in 12 coastal States, 33 plantings were found successful, 25 were partially successful, and 28 failed (43). Even planted marshes, however, were more frequently successful under less severe wave environments.

## Ground Water Recharge

Ground water recharge is the ability of a wetland to supplement ground water through infiltration/percolation of surface water to the saturated zone (88). Some wetlands that are connected hydrologically to a ground water system do recharge ground water supplies and assume an important local or regional role in maintaining ground water levels. However, owing to the low permeability of organic soils or the relatively impermeable layers of clay typically found in wetlands, adjacent upland areas often have a greater potential to recharge ground water (16). In addition, wetlands may often serve as discharge rather than recharge areas.[8]

Ground water recharge can occur in isolated (basin) wetlands, such as cypress swamps, prairie potholes, Midwestern and Northeastern glaciated wetlands, and flood plain wetlands. Cedarburg Bog, adjacent to Milwaukee, Wis., is an example of a high-value recharge area (58). Much of the precipitation falling on this basin percolates downward through the soil and enters openings in a dolomite aquifer. Since the bog occupies the basin of a former postglacial lake on a high point in the surrounding topography, the water percolates radially away from the bog, influencing ground water supply over an area of 165 $mi^2$.

While some wetlands may recharge ground water, their recharge value relative to upland areas may be low. In three watersheds in Minnesota, for instance, the greatest amount of ground water recharge was found to occur on upland sands, and the least in wetland peats (93). In addition, the quantity of water recharged may vary widely. For example, in one wetland studied only 39 gallons per day (gal/d), or 0.05 percent of the annual water budget, infiltrated the wetland (12). On the other hand, the average yearly natural recharge calculated for Lawrence Swamp in Massachusetts was

---

[8] Adamus and Stockwell, op. cit.

8 million gal/d (assuming 44 inches of precipitation/yr) (56).

The quality of the ground water resource also determines the value of a particular recharge area. While Lawrence Swamp recharges large quantities of water to the shallow aquifer directly underneath it, this aquifer has a high content of fine sands, iron, and manganese and cannot be used as a water supply (56).

## Water Quality Improvement

By temporarily retaining pollutants, such as suspended material, excess nutrients, toxic chemicals, and disease-causing micro-organisms, it is generally believed that wetlands improve, to varying degrees, the quality of the water* that flows over and through them. Dissolved nutrients (i.e., nitrogen and phosphorous) may be taken up directly by plants during the growing season and by chemical absorption and precipitation at the wetland soil surface. Organic and inorganic suspended material also tends to settle out and is trapped in the wetland. Some pollutants associated with this trapped material may be converted by biochemical processes to less harmful forms; some may remain buried. Others may be taken up by the plants growing in the wetland and either recycled or transported from it.

The accumulation of toxic chemicals, such as heavy metals and petroleum and chlorinated hydrocarbons by wetlands may be only temporary (from days to years). On the other hand, some toxic chemicals have accumulated in many wetlands over a much longer time. With some toxic chemicals, like degradable pesticides, the fact that these pollutants are secured in the wetland long enough to degrade is important. Other toxics either remain buried or are taken up by the wetland plants.

While wetlands may, under natural circumstances, retain nutrients on a net annual basis, the value of a particular wetland for water quality improvement depends on the effect of the nutrient storage on an adjacent or connected body of water. However, even if a wetland does not retain large amounts of nutrients on a net annual basis, it may influence the timing of nutrient inputs into adjacent waters. By retaining nutrients during the growing season, for instance, and exporting them after the growing season, wetlands may have a positive influence on water quality. Freshwater wetlands have been used successfully for secondary treatment of sewage effluents.

### Trapping Suspended Sediment

Excessively high levels of suspended material in the water column can be detrimental. By increasing turbidity, suspended sediment can interfere with fishing, swimming, and the esthetic appeal of water. Reduction in light penetration due to increased turbidity can kill aquatic plants, and settling of the suspended sediment can smother bottom-dwelling invertebrates and impair fish spawning. If suspended sediment has a high organic content, the dissolved oxygen level in the water column may decrease to levels that may adversely affect many organisms.

One of the major water quality functions of wetlands is the removal of suspended sediment. By reducing wave energy and the velocity of water flowing through the wetland, wetland plants encourage the deposition of suspended sediment. In fact, sedimentation rates are related directly to the density of marsh vegetation (7). Measurements of sediment accretion, most of which are for marine or estuarine environments, range from 0.04 centimeters (cm) to 1,100 cm/yr.[9]

The ability of vegetated wetlands to trap suspended sediment more effectively than similar unvegetated areas was shown clearly in an 8-year study on Currituck Sound in North Carolina. During the first 5 years, planted marsh lost an average of 1.4 $m^3$/linear m of beach/yr, while an adjacent unplanted area lost 3.3 $m^3$/yr. Between 1978 and 1979 the planted areas, however, captured an average of 1.5 $m^3$ of sediment/yr; the unplanted area lost an additional 1.3 $m^3$. From 1979 to 1980, the planted area gained 0.6 $m^3$ and the unplanted area lost 0.4 $m^3$. During the last year of the study, the planted area appeared relatively stable, while the unplanted area lost 1.0 $m^3$ (7).

---

*The term "water quality" is defined here as the chemical, physical, and biological condition of the water itself and not more broadly as the condition of the wetland and its associated habitat.

[9] Adamus and Stockwell, op. cit.

As the elevation of wetlands increases, accretion of sediment will slow. In one study, for instance, a Spartina marsh near the mean high-water level annually accreted from 2.0 to 4.25 millimeters (mm) of sediment. An area of colonizing Spartina at a lower elevation, however, accreted sediment at the rate of 9.5 to 37.0 mm/yr (10). Marshes tend to trap sediment as long as they are inundated by sediment-laden waters.

Suspended organic and nonorganic material has a strong tendency to adsorb other pollutants, including nutrients, pathogens, and toxics, such as heavy metals and chlorinated and petroleum hydrocarbons, that then are deposited with the sediment in wetlands (10). The ability of wetlands to "trap" suspended material greatly influences the fate of pollutants associated with the suspended material and the potential ability of a particular wetland to improve water quality.

### Removing Toxic Substances

Heavy metals, chlorinated and petroleum hydrocarbons, radionuclides, and other potentially harmful toxic substances may persist for many years. Because they tend to adsorb onto suspended material, toxics can be trapped in wetlands, either temporarily or permanently. At the sediment surface, these metals remain immobilized. Once buried and exposed to the anaerobic conditions that typically prevail in sediment, metals again can become mobile; however, they will be trapped within the sediment by the oxygenated zone at the sediment surface (54,55). Heavy-metal-removal efficiencies of wetlands vary from 20 to 100 percent, depending on the metals involved and the physical and biological variations that exist in wetland habitats (85).

For compounds such as heptachlor, lindane, or enderin, which degrade readily in soils, the trapping of the sediment results in a very efficient and permanent process for removing these contaminants from the water. (Natural or manmade alterations of the wetland caused by lowering the water table, dredging, and the like, however, could mobilize large quantities of toxic materials.) However, in general, it is not known yet to what extent wetlands processes are capable of removing toxic materials over the long term.

Some toxics may be taken up from the sediment by wetland plants and transferred through the food chain to higher trophic levels when the plant material is consumed, either directly by herbivores or as detritus. Food chain transfer will depend on the toxic chemical and its form as well as the characteristics of the plant species and the chemical's location in the plant. For example, food chain transfer is known to occur with some metals, such as mercury or cadmium, but may not occur with others, such as lead. Synthetic materials, including chlorinated hydrocarbons, are taken up by wetland plants, but food chain effects are not known. There probably is some selectivity of uptake of toxics by particular wetland plant species, but the available data are insufficient to indicate any universal trends. In summary, though wetlands may remove toxics from water, it is possible that such removal of heavy metals eventually may lead to contamination of higher trophic levels by passage up the food chain (42).

### Influencing Nitrogen and Phosphorus

Nitrogen and phosphorus are two nutrients that are necessary for the growth of algae. In excess, however, they can cause "blooms" of algal growth that can impart an unpleasant taste to drinking water and can interfere with recreational uses of water. In addition, the decomposition of algae can reduce levels of dissolved oxygen in the water column to levels that may be harmful to other organisms that need oxygen for survival.

Nutrients are retained in wetland by similar mechanisms as other pollutants (85). Both nitrogen and phosphorus readily adsorb to sediment and thereby tend to become trapped in the anaerobic sediment of wetlands. As with other toxics, however, nutrients are not necessarily permanently trapped; they may, for instance, be rapidly assimilated by rooted wetland plants. In fact, the bulk of the nitrogen and phosphorus for plant growth apparently comes from the sediment. At the end of the growing season, much of the assimilated nutrients may be leached from the plants. Boyd, for instance found that about 50 percent of the phosphorus in dead cattail tissue was leached over a

20-day period.* Another fraction of the nutrients in the plant is exported from the wetland as detritus; this fraction is probably highly variable, depending largely on the hydrology of the wetland. The dead plant tissue remaining in the wetland is rapidly colonized by bacteria and the byproducts of the decomposition process, including inorganic nutrients, are released into the water column. Nitrogen stored in the plant, for example, is converted by these decomposers to ammonia. Plant material remaining in the wetland is eventually reincorporated into the sediment. It has been hypothesized that a significant amount of the nitrogen and phosphorus available from the sediment for plant uptake is recycled from the plant growth of the previous year (42).

### Water Quality Considerations

**Aggregate Effect.**—Present understanding of the processes described above is not sophisticated enough to predict their aggregate effect on water quality. Nitrogen fixation, for instance, the opposite process of denitrification (atmospheric nitrogen is fixed by certain bacteria and algae), can contribute significant amounts of nitrogen to the wetland nitrogen budget and therefore cancel the effects of denitrification. Some wetland studies have measured the quantity of all pollutants entering the wetland from all sources—ground water, surface water, precipitation, and so forth—and the amount leaving the wetland. The aggregate effect of all wetland processes on water quality is reflected by the difference between the amount of pollutant entering and leaving the wetland. In this manner, it can be determined whether wetlands act as a sink or a source of pollutants.

Thirty-nine input-output studies, focusing for the most part on nitrogen and phosphorus, were reviewed. These studies were screened carefully to meet a number of stringent criteria. First, since the behavior of the wetland varies greatly during different seasons, only those studies sampling monthly for at least a year were selected. Second, all chemical forms of nitrogen and phosphorus had to be measured: measurement of both organic and inorganic forms is necessary since the various forms are interconvertible. For nitrogen, total nitrogen (Kjeldahl) must have been measured in unfiltered samples and in nitrate and nitrite. For phosphorus, measurement of total phosphorus from unfiltered samples was required. Third, for studies of undisturbed wetlands, all reasonable input and output sources had to be measured, including intermittent or temporary sources of surface runoff, ground water, and precipitation. In the case of an artificial pollution source, such as a sewage outfall, the failure to measure natural sources of nutrients was overlooked on the assumption that such sources were comparatively trivial. Measurement of all significant sources and sinks of water, however, was required, even if the quantity of naturally occurring nutrients was overlooked.

**Freshwater Systems.**—Of 30 freshwater input-output studies reviewed, only seven (12,23,27,52, 62,98,99), met all the criteria listed above. A major drawback of these studies is that large quantities of pollutants doubtlessly flow into and out of wetlands during storms or floods. The chance of getting a good sample of nutrients flowing into a wetland during a major flood is small if outflow is sampled only monthly. One study (52), for instance, found that 99 percent of the nutrient flow into a flood plain swamp occurred during a single flood. The swamp floods approximately once every 1.13 years.

Although Crisp (23) found a net export of nitrogen and phosphorus in an eroding British peatland, all other authors found net reductions of nutrients in freshwater wetlands. Large percentage reductions generally were observed where sewage was applied (12,27,98) and small percentage reductions were observed where nutrient sources were natural (52,62). One study (99) was unusual in that sewage and natural water were applied to artificially enclosed marsh plants so that surface outflow was prevented. Water that had filtered through the marsh sediments was sampled in outside wells. Since the natural hydrology of the marshes had been altered, the large percentage reductions in both the natural and sewage-treated marshes may not be representative of activity of natural marshes.

---

*The fate of nitrogen is more complicated than that of other pollutants thus far discussed. Nitrogen occurs in several forms in natural water: nitrite, nitrate ammonia, and organic nitrogen (proteins and other large molecules). In addition, the air contains over 78 percent nitrogen gas, which is exchanged continuously through the surface waters. Relatively large populations of micro-organisms in wetlands, under the right circumstances, can convert nitrogen from one form to another. Thus, nitrogen can be removed ultimately from water by microbial conversion to gas through the process of denitrification, or conversely, fixed from the atmosphere and converted to inorganic nitrogen.

**Estuarine Systems.**—Input-output studies are more difficult to conduct in estuarine or marine environments owing to tidal fluctuations. Nine estuarine studies were screened using the same criteria used for the freshwater studies. Findings from a single acceptable study (91) are reported in table 4. These results suggest that nitrogen was exported from a Massachusetts salt marsh.

**Evaluating Wetlands for Water Quality.**—To evaluate the value of a wetland for improving water quality, a number of factors must be considered. First is the condition of water in the water body adjacent to the wetlands. In many lakes, estuaries, and rivers, excessive nutrient concentrations cause undesirable algal blooms. In other bodies of water, however, desirable levels of primary productivity may be limited by a lack of these nutrients. If these waters have phytoplankton-based food chains, low nutrient concentrations can result in low productivity at all levels of the food chain. In this case, nutrients would be considered beneficial and not pollutants.

The reduction of excess nutrients necessary to bring about an improvement in water quality is another consideration. For instance, an evaluation of a proposal to reconstruct wetlands along the Kissimmee River in Florida and thereby reduce nutrient loadings to Lake Okeechobee, concluded that a 50-percent reduction in phosphorous loadings would improve water quality, but a 10-percent reduction would have little effect (41). In another study, lake-edge wetlands in Wisconsin did retain nitrogen and phosphorus; however, the levels of nutrients flowing out of the wetland still were high enough to cause excessive algal growth (47).

The timing of nutrient inputs and outputs also is important. A study of phosphorus inputs and outputs from a forested riverine wetland in Illinois found that while the swamp took in 11 times more phosphorus than was discharged, nearly all of it was retained during flood periods (52).

### Disease-Causing Micro-Organisms

Viruses and bacteria from sewage effluent or runoff from pastureland may contaminate drinking water, recreational water, and commercial fisheries. Because these micro-organisms are adsorbed onto particles suspended in the water column, they may be trapped along with the suspended material by wetlands. Pathogens can remain for many months in the soil matrix where they may be exposed to ultraviolet radiation or attacked by chemicals and other organisms, or they may naturally die off.

Table 4.—Summary of Input-Output Studies

| Reference | Wetland type | Location | Artificial/ natural | Sampling frequency/duration | Pollutant | Input | Output | Percent change |
|---|---|---|---|---|---|---|---|---|
| | | | | | | (kg/ha/yr) | | |
| Crisp (1966) | Peat bog | Britain | N | Weekly/1 year | N | 745 | 4,864 | +552 |
| | | | | | P | 38-57 | 71 | +25 - -87 |
| Mitsch, et al. (1977) | Flood plain swamp | Illinois | N | Monthly and bimonthly | P | 8,127 | 7,694 | -5 |
| Boyt, et al. (1977) | Riverine swamp | Florida | A | Monthly/1 year | P | 90.0 | 11.5 | -87 |
| Dierberg and Brezonik (1978) | Cypress swamp | Florida | A | Monthly/2 years | N | 144 | 12 | -91 |
| | | | | | P | 113 | 4 | -96 |
| Novitzki (1978) | Fresh marsh | Wisconsin | N | Monthly (stream, wells); periodically (runoff)/3 years | N | 233 | 183 | -21 |
| | | | | | P | 5.0 | 4.6 | -8 |
| | | | | | Sediment | 3,909 | 735 | -81 |
| Yonika and Lowry (1979) | Fresh marsh shrub swamp | Massachusetts | A | Monthly and bimonthly/ 1 year | N | 4,782 | 1,817 | -62 |
| | | | | | P | 859 | 205 | -76 |
| Zoltek and Bayley (1979) | Fresh marsh | Florida | A/N | Monthly/2 years | N | 3,565 | 2,284[a] | -36 |
| | | | | | F(art.) | 4,575 | 343[a] | -93 |
| | | | | | N(art.) | 645 | 315[a] | -51 |
| | | | | | P(nat.) | 46 | 16[a] | -65 |
| Valiela, et al. (1975) | Salt marsh | Massachusetts | N | Monthly/1 year | N(nat.) | 26,252 | 31,604 | +20 |

[a] Including ground water dilution calculated by chloride budget.

SOURCE: References cited in column 1.

There is little published information on the fate of pathogens in wetland systems (3).

## *Fish and Wildlife Values*

Wetlands are important to many species of fish and wildlife for food, habitat, and support of the food chain. The importance of plant productivity is reflected in the relatively high carrying capacity of wetlands for certain species. Bottom land hardwood forests, for instance, have been found to support nearly twice as many whitetail deer per unit area as do upland forests, owing, it is thought, to the abundance of food. Wetland vegetation also provides nesting material and sites for numerous birds and mammals; some freshwater fish rely on clumps of vegetation for depositing their eggs. Finally, emergent wetland plants provide the cover necessary for protection from predators or for stalking prey for species of birds as well as fish and shellfish. Some species spend their entire life within a particular wetland; others are residents only during a particular lifecycle or time of year.

Because of their value for food and habitat, wetlands often become a focal point for varied wildlife populations within a particular region. The importance of wetlands is reflected by the relatively large proportion of wetland in the National Wildlife Refuge System. While only 5 percent of the Nation's area (excluding Alaska) is wetland, nearly 40 percent of the area protected under the refuge system is wetland. In turn, these areas attract hunters, birdwatchers, and many other wildlife enthusiasts. Of the top 25 wildlife refuges most visited, 19 have a significant wetland component. Refuges containing wetlands attracted nearly 14 million visitors in 1981, approximately 50 percent of the number visiting all of the national wildlife refuges (90).

Because of their numbers, it is impossible to describe adequately all the different species that use wetlands. This section focuses on recreational and commercial species of prime importance to man and on endangered species that depend to varying degrees on the food and habitat found uniquely in wetlands. Some species, termed "wetland specialists," are heavily dependent on wetlands. They include migratory waterfowl, mammals, the alligator, freshwater game fish, crayfish, and 35 endangered species. Because of the direct link between wetlands and these species, wetland losses will cause significant and adverse impacts on these indigenous populations.

This section also identifies other wildlife that heavily use wetlands as well as other nonwetland areas. Deer, for instance, browse in bottom land hardwoods, but they are not limited to these areas. Wetland resources may, however, be a critical or limiting factor in their survival. Because these animals are not linked as strongly to wetlands as are wetland specialists, wetland losses would adversely affect populations of nonspecialists to a lesser extent.

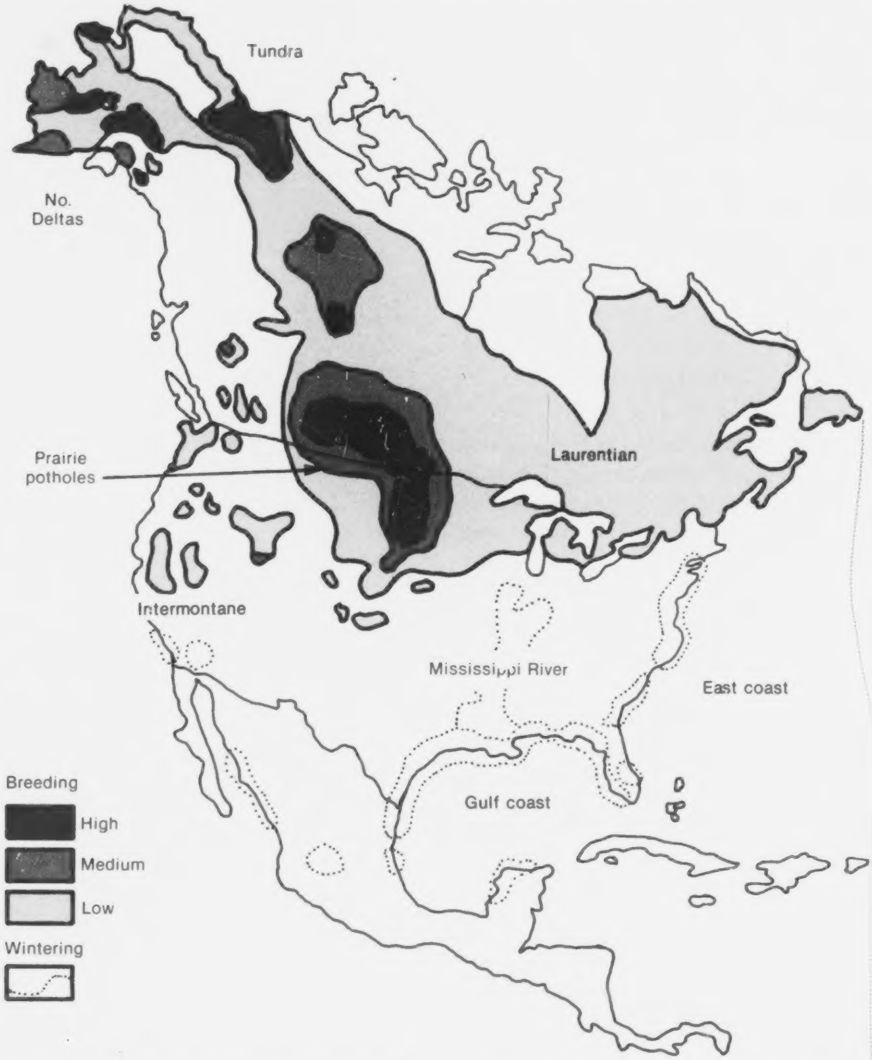
Finally, this section discusses the food chain values of wetlands. Many commercially and recreationally important species that do not directly use wetlands for feeding, nesting, or protection may feed on animals lower in the food chain that do rely directly either on wetlands or on detritus that floats from the wetland into adjacent bodies of water. The most important example of this food chain effect in terms of commercial and recreational value is the link between coastal wetlands and estuarine-dependent fish.

### Food and Habitat

**Migratory Waterfowl.**—Wetlands are vital to many species of the duck, geese, and swan family of North America for nesting, food, and cover. These birds primarily nest in Northern freshwater wetlands in the spring and summer, but use wetlands for feeding and cover in all parts of the country during migration and overwintering. The survival, return, and successful breeding of many species, therefore, depend on a wide variety of wetland types distributed over a large geographic area of the country (fig. 5). The major migratory routes, breeding and nesting areas, and overwintering areas roughly correspond with regions of greatest wetland concentration (see fig. 1).

The most important areas for ducks and geese are the breeding areas of the North, like the prairie-pothole region, Canada, and Alaska. For overwintering, the Chesapeake Bay, the gulf coast, the central valley of California, and the Mississippi River stand out (fig. 5). Also essential, but not in-

**Figure 5.—General Pattern of Duck Distribution in North America**


Tundra
No. Deltas
Prairie potholes
Laurentian
Intermontane
Mississippi River
East coast
Gulf coast
Breeding
High
Medium
Low
Wintering

SOURCE: M. Weller, *Freshwater Marshes: Ecology and Wildlife Management* (Minneapolis, Minn.: University of Minnesota Press, 1981).

dicated on figure 5, are coastal saltwater and freshwater tidal marshes, inland freshwater marshes, and bottom land hardwoods that are used as overwintering and stopover areas by migratory waterfowl during their biannual migrations (33). Shrub swamps are used only to a limited extent by waterfowl, and bogs and mangroves are used only sparsely (81).

While diets vary with any species and locality, depending on food preferences, availability, and the time of year, wetland vegetation generally comprises a significant component of the diet of ducks, geese, and swans. A major distinction between feeding habits can be drawn between "dabbling," or surface, ducks and "diving" ducks, or pochards.

The mallard, for instance, the most commonly hunted waterfowl in the United States, is a dabbling duck and feeds on plants and food just under the surface of the water. Bulrush, smartweed, and wildrice are the emergent wetland plants, and pondweed and wild celery are submerged plants favored by the mallard. In contrast, the canvasback, a diving duck, typically feeds in deeper water. They prefer submerged plants, such as pondweed, wild celery, and widgeon grass to emergent vegetation but still may feed on emergents when preferred foods are not available. Geese and swans, on the other hand, favor emergent wetland vegetation to submerged plants. Canadian and snow geese, in particular, feed on the rootstocks of salt marsh cordgrass as well as on cultivated crops (81).

Waterfowl also depend on wetlands for nesting sites. Inland freshwater and saltwater marshes and coastal tundra are the most important wetland types for waterfowl breeding (96). In general, waterfowl prefer wetlands where open water and vegetation are interspersed. Temporarily flooded wetlands have been known to have high breeding-pair densities, probably because of plentiful invertebrates, which breeding waterfowl require for egg production (96). Northern freshwater tidal marshes are used to a more limited extent for breeding, and wooded swamps and bottom land hardwoods are used by wood ducks for nesting (66,78).

Of the 44 species of waterfowl that use North American wetlands, 4 species of geese and 10 to 15 species of ducks are hunted in sizable numbers (6,59). In the 1980-81 season, for instance, 1.9 million people killed 12.9 million ducks and 1.7 million geese (13). FWS estimated that 50 percent of all hunters 16 years and older, or 5.3 million hunters, hunted migratory birds (includes nonwaterfowl) in 1980, spending $638 million, or 11 percent of all hunting expenditures (32). In addition, FWS estimated that of 100 million Americans 16 years and older who participated in outdoor activities related to fish and wildlife, 83.2 million participants spent $14.8 billion on observing and photographing fish and wildlife. Sixty-six percent of these participants were involved directly with observing or photographing waterfowl.

**Other Birds.**—There are several other types of birds that are found commonly in wetlands (48). The American coot is physically and ecologically similar to the duck and is shot in considerable numbers. Coots have diets similar to those of ducks but build floating nests in emergent vegetation. Snipe also inhabit freshwater marshes and wet meadows and are strictly carnivores, feeding on aquatic invertebrates they pull from mud with their long bills. The four rail species and the gallinules, which have special adaptations to wetlands, are commonly found there and are hunted to some extent. Herons, egrets, cranes, storks, and ibises nest colonially in wetlands. Herons and egrets feed on fish, frog, and invertebrates in shallow marsh waters. Ibises and storks nest over water in protected sites of deep marshes but feed in wet meadows and uplands.

**Mammals.**—A number of mammals live in wetlands. For example, muskrats may live in bank burrows or "houses" constructed of wetland vegetation along the banks of freshwater and saltwater marshes, rivers, and streams.[10] In freshwater their diets may consist of cattail, bulrushes, waterlilies,

Photo credit: U.S. Fish and Wildlife Service, Jim Leupold

A white-faced ibis tends its young in a marsh at Bear River National Wildlife Refuge. Many water birds depend on marsh vegetation for nesting sites wildrice, and pondweed. In salt marshes, they feed heavily on cordgrasses. They occasionally eat insects, clams, and crayfish. In coastal areas, muskrats reach their highest densities in brackish marshes dominated by bulrushes and cordgrasses.

---

[10] The following discussion is based on four sources of information: 1) Schamberger, et al. (80); 2) W. H. Burt and R. P. Grossenheider, *A Field Guide to the Mammals*, 3d ed. (Boston: Houghton-Mifflin, 1976); 3) F. C. Daibner, *Animals of the Tidal Marsh* (New York: Van Nostrand Reinhold, 1982); 4) Odum, et al. (68).

Another mammal, the nutria, is a related rodent that first was introduced from South America into Louisiana in 1938 for its fur. It is twice the size of the muskrat but is ecologically similar. Nutria prefer freshwater marshes, though they also may be found in low- to high-salinity marshes.

Mink that inhabit wetlands usually rely on crayfish and frogs in the North-Central States and prey heavily on muskrats during droughts and periods of muskrat overpopulation. However, fish are the most important food for a North Carolina population of mink, and crayfish are most important for mink in Louisiana. Mink appear to use the different coastal wetlands with equal success. In general, however, densities of these mammals are higher in freshwater rather than saltwater marshes.

Nutria are harvested for their fur in Louisiana, Maryland, the Carolinas, Texas, Oregon, and Washington. Mink and muskrat are taken in almost all States, though the majority are trapped in the wetland-rich States of the upper Midwest, the Dakotas, and Louisiana (68). In 1979-80, for instance, these species represented 32 percent of the total mammal-harvest value of approximately $295 million (for unfinished pelts).[11] This is a significant contribution to the fur industry, which recorded sales of almost $1 billion in 1980.

| | *Number harvested** | *Average pelt price* | *Total value (rounded)* |
|---|---|---|---|
| Muskrat | 8,634,753 | $ 8.63 | $74,526,548 |
| Nutria . . | 1,344,652 | 7.25 | 9,748,727 |
| Mink . . . | 394,214 | 22.42 | 8,838,277 |

*1979-1980 season

While mammals are harvested primarily for their pelts, they also are valuable for meat and various byproducts. During the 1979-80 season in Louisiana alone, 582,000 lbs of nutria and 18,000 lbs of muskrat, both valued at $0.04/lb, were harvested for meat; their combined value was $24,000.

**Alligators.**—Alligators are found in the wetlands of the Southeast, from North Carolina to Texas, preying on a variety of vertebrates, including mammals, birds, fish, and other reptiles. Alligators need shallow waters and banks for rest and warming in the sun. They use wetland vegetation for cover, protection, and nest construction. Controlled harvest of wild alligators for their hides and meat is permitted in some areas of Louisiana. In 1979, over 16,000 alligators worth about $1.7 million were harvested in the Louisiana coastal region (40).

---

[11] Information on the economic value of wetland furbearers comes from two sources: 1) Fur Resources Committee, International Association of Fish and Wildlife Agencies, fur harvest chart for the United States and Canada (27 species), 1979-80. Figures in text for the United States alone; and 2) Eugene F. Deems, Jr., and Duane Pursely, "North American Furbearers, A Contemporary Reference," International Association of Fish and Wildlife Agencies, 1982.

Photo credit: U.S. Fish and Wildlife Service

A nutria wading in a marsh at Belle Isle, La. These furbearers reach their greatest density in freshwater marshes, though they may also be found in low-to-high salinity marshes

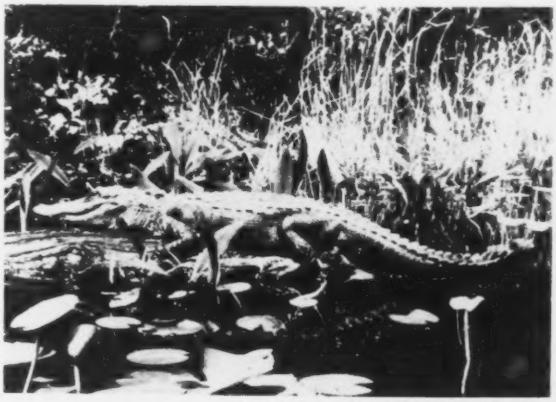


Photo credit: U. S. Fish and Wildlife Service

Alligators need shallow water and banks for rest and warming in the Sun. They use wetland vegetation for cover and nest construction

**Crayfish.**—Crayfish require the fluctuating water levels found in wetlands for mating and egg laying. Crayfish also feed primarily on wetland vegetation (46). Although there are commercial crayfish fisheries in Wisconsin and the Pacific Northwest, the most valuable crop comes from the Lower Mississippi River Basin, particularly Louisiana. Approximately 25 million lbs, representing revenues of $11 million, are harvested annually.*

**Fish and Shellfish.**—Many freshwater and saltwater fish require wetlands at some stage of their lifecycle.[12] Pike, pickerel, and muskellunge seem to prefer vegetated shallow water for broadcasting their eggs and may even spawn on land that is only temporarily flooded in the spring.[13] Large mouth bass spawn in the temporarily flooded zones of bottom land hardwoods. An abundant supply of invertebrates in these areas supply necessary food during a critical period after the fish eggs hatch (38). The alewife and the blueback herring spawn in freshwater tidal marshes and flood plain forests along the east coast (18).

Members of the perch family (including walleyes), the sunfish family (including bluegill, bass, and crappie), and the pike family (including pickerel and muskellunge) commonly are found in vegetated wetlands, owing to the protection from predators afforded by the vegetation, strong currents, sunlight, and the fact that the prey of all these fish often take refuge in the wetland. Grey snapper, sheepshead, spotted sea trout, and red drum move into mangroves after spending their first few weeks in submerged seagrass beds. These fish feed heavily on either small fishes or amphipods (86).

Juvenile marine fish and shellfish also use coastal marshes, particularly marshes of intermediate salinity, because this salinity excludes both marine and freshwater predators (2). (See table 5 for a list of species.) Pacific coast wetlands probably do not serve the same nursery function as do the Atlantic coast and gulf coast wetlands (68).

**Table 5.—Selected Commercial or Sport Fish and Shellfish Utilizing Coastal Marshes as Nurseries**

- Sand seatrout
- Weakfish
- Croaker
- Spot
- Menhaden
- Striped mullet
- Bay anchovy
- Striped bass
- White perch
- Silver perch
- Summer flounder
- Brown and white shrimp

SOURCE: Odum, et. al., 1979, op. cit., note 68.

**Endangered Species.**—Approximately 20 percent of all plant and animal species found on the Federal Government's list of endangered or threatened species heavily depend on wetlands for food and/or habitat (table 6). Many other plant and animal species not included on the Federal list are found on State lists. A number of endangered species not listed in table 6 also may use wetland resources to a greater or lesser extent.[14]

**Other Wildlife.**—While relatively few animals depend entirely on resources found only in wetlands, many animals heavily exploit wetland resources. Foxes and raccoons, for instance, may prefer den sites in wetlands, owing to their close proximity to the water (72). In fact, the availability of wetland resources may determine the health and survival of many animals during critical times. Wetlands, for instance, are preferred by deer, pheasants, and other animals as winter cover because of the presence and availability of food. Cedar swamps, for example, are the only feeding grounds that can sustain white-tailed deer through northern Michigan winters. In Minnesota, white-tailed deer spend 80 percent of their time in wetlands between December and April (79).

During droughts and dry years, wetlands serve as reservoirs that are extremely important to regional wildlife stability. Southeastern swamps provide food resources when upland resources are unavailable (57). In a survey conducted by FWS, State

---

*Calculation of the crayfish catch ($11 million, 25 million lbs), based on data supplied by Larry Delabreteonne.

[12] Adamus and Stockwell, op. cit.

[13] Information comes from two sources: 1) C. L. Hubbs and K. F. Lagler, "Fishes of the Great Lakes Region," Cranbrook Institute of Science, Bulletin No. 26, Bloomfield Hills, Mich., 1958; 2) M. B. Trautman, "The Fishes of Ohio," Ohio State University Press, Columbus, 1957.

[14] For a more complete review of the species that use wetlands, see John Kusler, "Our National Wetland Heritage: A Protection Guidebook," Environmental Institute, Washington, D.C., 1978. The table was prepared by the Office of Endangered Species and subjected to approximately 30 reviews.

**Table 6.—Endangered Wetland Species on the Federal Endangered and Threatened Species List**

| Range | Species (including subspecies, groups of similar species, and genera) |
|---|---|
| Alaska, Northwest California | Aleutian Canada goose |
| California | Saltmarsh harvest mouse<br>California clapper rail<br>Light-footed clapper rail<br>San Francisco garter snake<br>Desert slender salamander<br>Santa Cruz long-toed salamander<br>Delta green ground beetle<br>Truckee barberry<br>San Diego mesa mint<br>Crampton's Orcutt grass<br>Saltmarsh bird's beak (a snapdragon) |
| California, Arizona | Yuma clapper rail |
| Carolinas to Texas, California | Brown pelican |
| Rocky Mountains east to Carolinas | Whooping crane |
| Iowa | Iowa pleistocene snail |
| Southeast | American alligator<br>Houston toad<br>Pine barrens tree frog |
| Carolinas | Bunched arrowhead |
| Florida | Everglades kite<br>Cape Sable seaside sparrow<br>Dusky seaside sparrow<br>American crocodile<br>Atlantic saltmarsh snake |
| Appalachians | Chittenango ovate amber snail |
| Massachusetts | Plymouth red-bellied turtle |
| Maine | Furbish lousewort |
| Hawaii | Hawaiian coot<br>Hawaiian duck<br>Laysan duck<br>Hawaiian gallinule<br>Hawaiian stilt |
| Guam, Marianas Islands | Marianas mallard |

SOURCE: Office of Technology Assessment.

game managers identified the game and fur animals that use wetlands in their States (table 7). A large number of nongame species were found to use wetlands.

### Food Chain Support

The infusion of nutrients that comes with spring flooding, combined with the nutrients already stored in wetland soils, results in wetland plant productivity that often is significantly higher than the productivity of adjacent open-water or upland areas. For instance, the fertility of flood plains, resulting from the annual deposits of enriched sediment carried by spring floods, is widely recognized. Similarly, coastal salt marshes and certain types of inland freshwater wetlands that receive a regular supply of nutrients achieve some of the highest rates of plant productivity of any natural ecosystem.

**Table 7.—Game and Fur Animals Identified by State Game Managers as Found in Wetlands**

***Small game:***
Grouse, ruffed
Grouse, sage
Grouse, sharp-tailed
Hungarian partridge
Mourning dove
Pheasant
Quail, bobwhite
Quail, Gambel's
Quail, valley
Rabbit, cottontail
Rabbit, swamp
Snowshoe hare
Snipe
Squirrels (gray and fox)
Woodcock

***Big game:***
Antelope
Black bear
Black-tailed deer
Elk
Mouse
Mule deer
White-tailed deer

***Fur animals:***
Beaver
Bobcat
Fox (red and gray)
Opossum
Otter
Raccoons
Skunk
Weasel

SOURCE: S. T. Shaw and G. C. Fredine, *Wetlands of the United States*, U.S. Department of the Interior, Fish and Wildlife Service, 1971

Plant material produced by wetlands may be an important link in the food chain. In bottom land hardwood areas, decomposing leaves serve as the base for springtime explosions in populations of invertebrates, which are an important source of protein for egg-laying waterfowl. Many researchers also have examined the importance of detritus from estuarine marshes as food for commercially and recreationally valuable estuarine fish. Wetlands generally produce a great deal of plant material, some of which is flushed into the estuary in the form of detritus. In some estuaries, such as those found along the Georgia and Louisiana coasts, where the ratio of marsh to open water is high, detritus is a major component of the diet of estuarine fish.

**Potential Importance of Estuarine Fish and Shellfish From Wetlands.**—Table 8 shows the 10 most recreationally important species of marine fish, judging by estimated number of fish landed.

**Table 8.—The 10 Most Recreationally Important Marine Fish in the United States in 1979 Ranked by Number of Fish Landed**

| | Thousands of fish | |
|---|---|---|
| | Estuarine | Nonestuarine |
| Flounders (summer and winter) | 38,649 | |
| Bluefish[a] | | 27,332 |
| Seatrout (3 species) | 22,440 | |
| Sea catfishes | | 20,727 |
| Spot | 18,480 | |
| Atlantic croaker | 16,505 | |
| Pinfish | | 12,811 |
| Perch (4 species) | 9,556 | |
| Snappers (Several) | | 9,363 |
| Grunts (several) | | 8,606 |
| Total | 105,630 (57%) | 78,839 (43%) |

[a]Disagreement over estuarine dependence.

SOURCE: National Marine Fisheries Service, "Fisheries of the United States, 1980," Current Fishery Statistics No. 8100, 1981.

Out of an estimated 2.98 million marine fish caught by recreational fishermen in the United States in 1979, 5 out of the top 10 species, or 57 percent by number, were estuarine-dependent. By weight, they comprised about 62 percent of the total catch of 438.6 million lbs.

The percentage of estuarine-related fish and shellfish out of the total U.S. fisheries harvest is high.* Table 9 shows the 15 most important species or groups of species commercially harvested by U.S. fishermen in 1980, ranked by their dockside value.[15] Eight of these fifteen species commonly are found in estuaries at least sometime during their lifecycles. They represent 61 percent of the dockside value and 77 percent of the total weight of the catch of the 15 groups listed. Commercial landings by U.S. fishermen for fish and shellfish in U.S. ports totaled 6.48 billion lb in 1980, with a dockside value of $2.23 billion. Approximately 4.08 bil-

---

*It should be noted that there is disagreement on which fish should be considered "estuarine." This rises partially from different definitions of the term and partially from lack of knowledge regarding many of the details of marine fish life histories. For this discussion, we have used Stroud's (1971) survey of 15 fisheries biologists on the estuarine dependence of nearly 100 fishes.

[15] Estimated total catch, all regions, from National Marine Fisheries Service, 1981. Estuarine dependence based on McHugh (1966) and Stroud (1971). 1) National Marine Fisheries Service, "Fisheries of the United States, 1980," Current Fishery Statistics No. 8100, 1981; 2) J. L. McHugh, "Management of Estuarine Fisheries," *A Symposium on Estuarine Fisheries*, American Fisheries, Soc. Spec. Publ. No. 3, 1966, pp. 133-154; 3) R. H. Stroud, "Introduction to Symposium," *A Symposium on the Biological Significance of Estuaries*, P. A. Douglas and R. H. Stroud (eds.) (Washington, D.C.: Sport Fishing Institute, 1971).

**Table 9.—The 15 Most Important Fish and Shellfish Harvested by U.S. Fisheries in 1980**

| | Thousands of dollars | | Thousands of pounds | |
|---|---|---|---|---|
| | Nonestuarine | Estuarine | Nonestuarine | Estuarine |
| Shrimp (several species, all coasts) | — | $ 402,697 | — | 339,707 |
| Salmon (5 species) | — | 532,277 | — | 613,811 |
| Tuna (6 species) | $233,125 | — | 399,432 | — |
| King crab | 168,694 | — | 185,624 | — |
| Menhaden (Atlantic and Gulf) | — | 112,012 | — | 2,496,649 |
| Sea scallops | 110,429 | — | 28,752 | — |
| Flounders (several species, all coasts) | — | 82,488 | — | 216,920 |
| American lobster | 75,233 | — | 36,952 | — |
| Oyster | — | 70,075 | — | 49,081 |
| Snow, or tanner crab | 55,161 | — | 121,674 | — |
| Sea herring (Atlantic and Pacific) | 44,955 | — | 291,069 | — |
| Hard clam | — | 44,068 | — | 13,370 |
| Blue crab | — | 55,167 | — | 163,206 |
| Atlantic cod | 31,883 | — | 118,245 | — |
| Dungeness crab | — | 21,613 | — | 38,025 |
| Total | $719,480 | $1,120,397 | 1,181,748 | 3,930,769 |
| Percent | 39% | 61% | 23% | 77% |

SOURCE: National Marine Fisheries Service, "Fisheries of the United States, 1980," Current Fishery Statistics No. 8100, 1981.

lion lbs of estuarine fish and shellfish species were landed by U.S. commercial fishermen in 1980. This represented 63 percent of total U.S. commercial landings at U.S. ports, with a dockside value of $1.15 billion, 51.5 percent of the value of the total catch. The retail value of the estuarine-related catch is more speculative.

**Factors Affecting Production of Plant Material.**—The production of plant material in wetlands generally is high relative to other upland ecosystems, such as grasslands (table 10), largely because of the flux of nutrients and water through wetlands (75). In general, production of plant material will be greatest in wetlands of flowing or regularly fluctuating water and lowest in stillwater wetlands (unless enriched by nutrients) (14). Approximately 15 percent or less of the annual plant growth of coastal marshes* is harvested by direct feeding by macroinvertebrates such as fiddler crabs, snails, amphipods, and polychaete worms (49). After the growing season, most standing plant material on marshes dies.

Up to 70 percent of the net primary productivity of coastal wetlands may be exported from the wetland to open-water areas (49). The amount exported will vary—in the "high marsh," only 10 percent may be exported, while areas adjacent to the water's edge may export much more. In some cases, there may be no net export. Any detrital particles exported from the marsh rapidly are colonized by bacteria, fungi, and other micro-organisms which increase the concentration of protein and fatty acid content, enhancing caloric value. These microbes also adsorb dissolved organic compounds from the surrounding water. As a result, the original plant material is transformed into a nutritious food source for filter feeders.[16]

**Table 10.—Wetland Plant Productivity**
**(metric tons per hectare per year)**

| | Range |
|---|---|
| ***Coastal:*** | |
| Salt marshes (aboveground only): | |
| Louisiana and Georgia | 22 |
| North Atlantic | 4-7 |
| Pacific coast | 3-19 |
| Freshwater tidal wetlands (above and below ground) | 13-16 |
| ***Inland:*** | |
| Freshwater marshes (above and below ground): | |
| Sedge-dominated marshes | 9-12 |
| Cattail marshes | 20-34 |
| Reed | 15-27 |
| Bogs (above and below ground) | 4-14 |
| Wooded swamps | 7-14 |

SOURCE: *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 146-161.

---

*This discussion pertains to coastal marshes. Limited research indicates that dissolved organic compounds and decaying plant material are exported from inland wetlands at a greater rate than from uplands of equivalent area.

[16] Sather and Smith, op. cit.

Analysis of the stomach contents of estuarine fish and shellfish shows a wide variety of foods. For instance, the stomach contents of menhaden include primarily algae, but also detritus, small crustaceans, and even small fish and fish eggs (50). Commercial shrimp seem to have an even broader diet, consisting of single-celled algae, algal filaments, detritus, bacteria, protozoa, and easily captured animals, including very small worms and crustaceans (25). Analysis of the stomach contents of oysters and hard clams often shows both detritus from vascular plants and phytoplankton, probably from the open estuary. However, there is evidence that most of the food value comes from the phytoplankton (37,69,84).

While commercially and recreationally important fish may not directly consume detritus as their major food source, they may feed on invertebrates that use detritus as a major food source. Newly hatched Atlantic croaker, for instance, eat the small crustaceans found in the water column, particularly various copepods commonly found in the tidal creeks dissecting grassy salt marshes (2). As they grow, they add larger items to their diets, such as amphipod crustaceans, mysid shrimp, small crabs, worms of all sorts, mollusks, and smaller fish (69, 84). Also, opposum shrimp, a common marsh invertebrate, is a major component of the diet of striped bass on both the east and west coasts. Chironomid midge larvae were found to account for over 80 percent of the diet of juvenile chum and chinook salmon (24).

Most coastal marshes export detritus to adjacent coastal waters. While estuarine fish and shellfish may directly and indirectly use detritus when available, the quantitative significance of wetlands-derived detritus to the food supply of the estuary relative to contributions of detritus from other terrestrial or open-water food sources generally is not known, but probably varies widely with both species and estuary. If the estuary has very few marshes and much open water, such as in the North and Middle Atlantic States and most areas in the Pacific, the likelihood is increased that the ultimate source of organic matter for fish is not the marsh grass, but the phytoplankton. For example, Chesapeake Bay is the source of a great deal of commercially valuable seafood, but its ratio of marsh to open water is only 0.04; the ratio at Sapelo Island, Ga., is nearly 2.0. Given what is known about the phytoplankton production in the Chesapeake Bay, the annual contribution of salt marshes to total available energy is only around 2 to 5 percent (61). In fact, the scientific literature lacks convincing evidence, at least for Atlantic and Pacific coasts, supporting the belief that coastal marshes play a significant role in supporting fish and shellfish productivity through the export of detritus (68).

## *Climatic and Atmospheric Functions*

Although there has been little research related to these functions, some wetland scientists have hypothesized that large wetlands help to maintain lower air temperatures in the summer and prevent extremely low temperatures in the winter. They also are a source of water to the atmosphere, leading to the formation of cumulus clouds, thunderstorms, and precipitation. Finally, wetlands, through processes of microbial decomposition, either may store or emit gaseous byproducts important to global atmospheric stability.

### Moderation of Local Temperatures

Water warms and cools slowly in comparison with land areas; thus, wetlands will have a moderating influence on daily atmospheric temperatures. Drained agricultural areas in Florida, for instance, were found to be 5° F colder in the winter than were surrounding, undrained areas (35). It has been suggested that wetland drainage of the Everglades may have increased frost action (87). Because deeper water bodies contain more water than wetlands with the same area, lakes will have a more moderating influence on atmospheric temperature than will wetlands (35).

### Maintaining Regional Precipitation

Wetlands contribute to rainfall through processes of evaporation and the release of water vapor from plants (evapotranspiration). In a study of Florida cumulus clouds, for instance, lakes larger than 1 mile in diameter exerted a noticeable effect on clouds in the area (35). It has been hypothesized that wetland drainage could reduce summer thunderstorm activity in Florida by reducing evapotransporation, leading in turn to regional rainfall deficits (22).

### Maintain Global Atmospheric Stability

There is increasing concern now that increases in atmospheric nitrous oxide from man's activities may adversely affect the stratosphere and may influence the radiative budget of the troposphere. Studies on tidal salt marshes have shown that microbial decomposition in wetland soils under anaerobic conditions can convert nitrous oxide to other chemical forms. The importance of this process on a global scale remains unclear (36).

Terrestrial detritus may form one of the largest but least accurately known pools of carbon in the biosphere. It generally is agreed that the world pool of detrital carbon is several times larger than the total carbon content of the atmosphere or of the world biota. A significant fraction of detritus is found as peat or in the highly organic soils of wetlands (34). If left undisturbed, the carbon in these organic soils remains as reduced organic carbon. Since the mid-19th century, the conversion of wetlands has resulted in the oxidation of organic matter in the soil and the release of carbon dioxide to the atmosphere (65). Many scientists feel that increasing levels of carbon dioxide in the atmosphere will lead to global warming.

Methane, a byproduct of microbial decomposition of organic material in wetlands, also is thought to function as a sort of homeostatic regulator for the ozone layer that protects modern aerobic life from the deleterious effects of ultraviolet radiation (65).

# CHAPTER 3 REFERENCES

1. Anderson-Nichols & Co., Inc., "Neponset River Basin Flood Plain and Wetland Encroachment Study," Massachusetts Water Resources Commission, 1971, p. 61.
2. Arnoldi, D. C., Herke, W. H., and Clairain, E. J., Jr., "Estimates of Growth Rate and Length of Stay in a Marsh Nursery of Juvenile Atlantic Croaker, *Micropogon udulatus* (1.), 'Sandblasted' With Fluorescent Pigments," *Gulf Caribb. Fish. Inst. Proc.*, vol. 26, 1979, pp. 158-172.
3. Association of Bay Area Governments, "The Use of Wetlands for Water Pollution Control," contract report to the Municipal Environmental Research Labotatory, Environmental Protection Agency, Cincinnati, Ohio, 1981.
4. Athearn, W. D., Anderson, G. L., Byrne, R. J., Hobbs, D. H., III, and Ziegler, J. M., "Shoreline Situation Report: Northampton County, Virginia," *Chesapeake Research Consortium Report*, No. 9, 1974.
5. Bay, R. R., "Runoff From Small Peatland Watersheds," *Journal of Hydrology*, vol. 9, 1969, pp. 90-102.
6. Bellrose, F. C., "Ducks, Geese, and Swans of North America," Wildlife Management Institute, Stackpole Books, Harrisburg, Pa., 1976, p. 544.
7. Benner, C. S., Knutson, P. L., Brochu, R. A., and Hurme, A. K., "Vegetative Erosion Control in an Oligohaline Environment, Currituck Sound, North Carolina," *Third Annual Meeting of the Society of Wetland Scientists*, Wrightsville Beach, N.C., May 16-19, 1982.
8. Bernot, C., "Water Bank: Keeping Wetlands Wet," *The Minnesota Volunteer*, vol. 42, No. 246, September/October 1979, p. 4.
9. Boelter, D. H., and Verry, E. S., "Peatland and Water in the Northern Lake States," USDA Forest Service General Technical Report NC-31, North-Central Forest Experiment Station, St. Paul, Minn., 1977.
10. Boto, K. G., and Patrick, W. H., Jr., "Role of Wetlands in the Removal of Suspended Sediments," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 479-489.
11. Boyd, C. E., "Losses of Mineral Nutrients During Decomposition of *Typha latifolia*," *Arch. Hydrobiol.*, vol. 66, No. 4, 1970, pp. 511-517.
12. Boyt, F. L., Bayley, S. E., and Zoltek, J., "Removal of Nutrients From Treated Municipal Wastewater by Wetland Vegetation," *Journal of the Water Pollution Control Federation*, vol. 49, 1977, pp. 789-799.
13. Brackhage, G., Office of Migratory Bird Management, Fish and Wildlife Service, personal communication with OTA, May 3, 1982.
14. Brinson, M. M., Lugo, A. E., and Brown, S., "Primary Productivity, Decomposition and Con-

sumer Activity in Freshwater Wetlands," *Annual Review of Ecology and Systematics*, vol. 12, 1981, pp. 123-161.

15. Carter, V., Bedinger, M. S., Novitzki, R. P., and Wilen, W. O., "Water Resources and Wetlands," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 334-376.
16. Cernohous, L., "The Value of Wetlands as Flood Control," unpublished manuscript compiled for the U.S. Fish and Wildlife Service, Bismarck Area Office, Bismarck, N. Dak., 1979.
17. Clairain, E. J., Cole, R. A., Diaz, R. J., Ford, A. W., Huffman, R. I., and Wells, B. R., "Habitat Development Field Investigations, Miller Sands Marsh and Upland Habitat Development Site, Columbia River, Oregon," Summary Report, Technical Report D-77-38, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss., 1978.
18. Clark, J., "Freshwater Wetlands: Habitats for Aquatic Invertebrates, Amphibians, Reptiles, and Fish," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 330-343.
19. Clark, J. R., and Benforado, J., "Report on a Bottomland Hardwood Wetlands Workshop," Lake Lanier, Ga., June 1-5, 1980.
20. Coordinating Council on Restoration of the Kissimmee River Valley and Taylor Creek-Nubbin Slough Basin, "Symposium Summary, Regional Influence of Drainage of the Hydrologic Cycle in Florida," July 1982.
21. Council on Environmental Quality, "Our Nation's Wetlands," An Interagency Task Force Report, 1978, p. 70.
22. Cowardin, L. M., Carter, V., Golet, F. C., and LaRoe, E. T., "Classification of Wetlands and Deepwater Habitats of the United States," U.S. Fish and Wildlife Service, 1979, p. 103.
23. Crisp, D. T., "Input and Output of Minerals for an Area of Pennine Moorland: The Importance of Precipitation, Drainage, Peat Erosion, and Animals," *Journal of Applied Ecology*, vol. 3, 1966, pp. 327-348.
24. Crow, J. H., and MacDonald, K. B., "Wetland Value: Secondary Production," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 146-161.
25. Dall, W., "Food and Feeding of Some Australian Penaeid Shrimp," *Proc. World Su. Conf. Biol, and Culture of Shrimps and Prawns*, Fish. Rep. F.A.D., vol. 57, 1968, pp. 251-258.
26. Dibner, P. C., "Response of a Salt Marsh to Oil Spill and Cleanup: Biotic and Erosional Effects in the Hackensack Meadowlands, New Jersey," NTIS Report No. PB-285-211, 1978.
27. Dierberg, F. E., and Brezonik, P. L., "The Effect of Secondary Sewage Effluent on the Surface Water and Groundwater Quality of Cypress Domes," *Cypress Wetlands for Water Management, Recycling, and Conservation*, 4th Annual Report to the National Science Foundation, H. T. Odum and K. C. Ewel (eds.) (Gainesville, Fla.: University of Florida, 1978), pp. 789-799.
28. Ehrenfeld, D. W., "The Conservation of Non-Resources," *American Scientist*, vol. 64, 1976, pp. 648-656.
29. Elder, J. F., and Cairns, J., "Production and Decomposition of Forest Litter Fall on the Appalachicola River Floodplain, Florida," U.S. Geological Survey Water-Supply Paper 2196, 1983.
30. Elkins, J. W., Wofsy, S. C., McElroy, M. B., Kolb, C. E., and Kaplan, W. A., "Aquatic Sources and Sinks for Nitrous Oxide," *Nature*, vol. 275, 1978, pp. 602-606.
31. Fagan, G. L., Jr., "Analysis of Flood Hydrographs From Wetland Areas," Ph. D. dissertation, available from University Microfilms, No. 81-18860, 1981.
32. Fish and Wildlife Service, "The 1980 National Survey of Fish, Hunting and Wildlife-Associated Recreation," Portland, Oreg., 1982.
33. Flake, L. D., "Wetland Diversity and Waterfowl," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 312-319.
34. Friedman, R. M., and DeWitt, C. B., "Wetlands as Carbon and Nutrient Reservoirs: A Spatial, Historical, and Societal Perspective," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 175-185.
35. Gannon, P. T., Barthdic, J. F., and Bill, R. G., "Climatic and Meteorological Effects on Wetlands," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 576-588.
36. Germain, C., Wisconsin Scientific Areas Program,

personal communication with Joan Harn, OTA, Dec. 14, 1981.

37. Haines, E. B., and Montague, C. L., "Food Sources of Estuarine Invertebrates Analyzed Using $^{13}C/^{12}C$ Ratios," *Ecology*, vol. 60, 1979, pp. 48-56.
38. Hall, D. H., "A Synopsis of the Values of Overflow in Bottomland Hardwoods to Fish and Wildlife," U.S. Fish and Wildlife Service, Ecological Services, 1979.
39. Hobbs, C. H., Byrne, R. J., Kerns, W. R., and Barber, N. J., "Shoreline Erosion: A Problem in Environmental Management," *Coastal Zone Management Journal*, vol. 9, No. 1, 1981, pp. 89-105.
40. Jantzen, R., Director, U.S. Fish and Wildlife Service, testimony before House Subcommittee on Fisheries, Wildlife Conservation, and the Environment, Nov. 20, 1981.
41. Jones, R. A., and Lee, G. F., "An Approach for the Evaluation of Efficacy of Wetlands-Based Phosphorus Control Programs for Eutrophication-Related Water Quality: Improvement in Downstream Waterbodies," *Water, Air and Soil Pollution*, vol. 14, 1980, pp. 359-378.
42. Kadlec, R. H., and Kadlec, J. A., "Wetlands and Water Quality," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 436-456.
43. Knutson, P. L., Ford, J. C., Inskeep, M. R., and Oyler, J., "National Survey of Planted Salt Marshes," *Wetlands*, September 1981.
44. Knutson, P. L., and Selig, W. N., "Wave Damping in *Spartina Alterniflora* Marshes," *Third Annual Meeting of the Society of Wetland Scientists*, Wrightsville Beach, N.C., May 16-19, 1982.
45. Kroodsma, D. E., "Habitat Values for Nongame Wetland Birds," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 320-329.
46. LaCraze, C., "Crawfish Farming," Louisiana Department of Wildlife and Fisheries, Baton Rouge, La., Fisheries Bulletin No. 7, 1981.
47. Lee, C. R., Bentley, E., and Amundson, R., "Effects of Marshes on Water Quality," *Coupling Land and Water Systems*, A. D. Hasler (ed.) (New York: Springer-Verlag, 1975), pp. 105-127.
48. Leopold, A. S., Gutierrez, R. J., and Bronson, M. T., *North American Game Birds and Mammals* (New York: Scribner, 1981).
49. McCormick, J., and Somes, H. A., Jr., "The Coastal Wetlands of Maryland," Maryland Department of Natural Resources, 1982.
50. McHugh, J. L., "Estuarine Nekton," *Estuaries*, G. Lauff (ed.), publication 82 (Washington, D.C.: American Association for the Advancement of Science, 1967), pp. 581-620.
51. Miller, E. G., "Effect of Great Swamp, New Jersey on Streamflow During Baseflow Periods," U.S. Geological Survey Professional Paper 525-B, 1965, pp. B-177-179.
52. Mitsch, W. J., Dorge, C. L., and Weimhoff, J. R., "Forested Wetlands for Water Resource Management in Southern Illinois," University of Illinois at Urbana-Champaign Water Resources Center, Research Report No. 132, NTIS No. PS 276 659, 1977.
53. Morine, D., Vice President for Land Acquisition, the Nature Conservancy, and Lowe, G., Executive Vice President, the Nature Conservancy, personal communication with OTA, Apr. 19, 1983.
54. Mortimer, C. H., "The Exchange of Dissolved Substances Between Mud and Water in Lakes, Parts I and II," *J. Ecol.*, vol. 29, 1941, pp. 280-329.
55. Mortimer, C. H., "The Exchange of Dissolved Substances Between Mud and Water and Lakes, Parts III and IV," *J. Ecol.*, vol. 30, 1942, pp. 147-201.
56. Motts, W. S., and O'Brien, A. L., "Geology and Hydrology of Wetlands in Massachusetts," Water Resources Research Center, University of Massachusetts, Amherst, Publication No. 123, 1981.
57. Mulholland, L. D., "Importance of Southeastern Swamps to North American Birds and Mammals," presented at the *Third Annual Meeting of the Society of Wetland Scientists*, 1982.
58. Mulica, W. S., and Lasca, N. P., "A Bog-Controlled Groundwater Recharge System in an Area of Urban Expansion," *Proceedings of Second World Congress, International Water Resources Association*, vol. III, New Delhi, December 1974, pp. 175-194.
59. National Academy of Sciences, *Impacts of Emerging Agricultural Trends on Fish and Wildlife Habitat* (Washington, D.C.: National Academy Press, 1982).
60. National Park Service, "National Park Statistical Abstract," available from the Statistical Office, Denver Service Center, U.S. Department of the Interior, 1981.
61. Nixon, S. W., "Between Coastal Marshes and Coastal Rivers—A Review of Twenty Years of

Speculation and Research on the Role of Salt Marshes in Estuarine Productivity and Water Chemistry," *Estuarine and Wetland Processes With Emphasis on Modeling*, Hamilton and MacDonald (eds.) (New York: Plenum Press, 1979), pp. 437-511.

62. Novitzki, R. P., "Hydrology of the Nevin Wetland Near Madison, Wisconsin," U.S. Geological Survey, Water Resources Investigation 78-48, NTIS No. PB-284 118, 1973.
63. Notitzki, R. P., "The Hydrologic Characteristics of Wisconsin's Wetlands and Their Influence on Flood, Streamflow, and Sediment," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 377-388.
64. O'Brien, A. L., "Hydrology of Two Small Wetland Basins in Eastern Massachusetts," *Water Resources Bulletin*, vol. 13, No. 2, 1977, pp. 325-340.
65. Odum, E. P., "The Value of Wetlands: A Hierarchical Approach," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 16-25.
66. Odum, W. E., Dunn, M. L., and Smith, T. J., III, "Habitat Value of Tidal Freshwater Wetlands," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 248-255.
67. Ogawa, H., "Evaluation Methodologies for the Flood Mitigation Potential of Inland Wetlands," Ph. D. dissertation, University of Masachusetts, Amherst, 1982.
68. Onuf, C. P., Quammen, M. L., Shaffer, G. P., Peterson, C. H., Chapman, J. W., Cermak, J., and Holmes, R. W., "An Analysis of the Values of Central and Southern California Coastal Wetlands," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 186-199.
69. Overstreet, R. M., and Heard, R. W., "Food of the Atlantic Croker, *Micropogonias undulatus*, From Mississippi Sound and the Gulf of Mexico," *Gulf Res. Rept.* 6, 1978, pp. 145-152.
70. Owens, R. E., III, "The Economic Value of the Use of Virginia's Coastal Wetlands as an Erosion Control Strategy," Virginia Polytechnic Institute and State University, M.S. thesis, Blacksburg, Va., 1980.
71. Pestrong, R., "The Shear Strength of Tidal Marsh Sediments," NTIS No. AD-765 273, 1973.
72. Porter, B. W., "The Wetland Edge as a Community and Its Value to Wildlife," *Selected Proceedings of the Midwest Conference on Wetland Values and Management*, B. Richardson (ed.), 1981.
73. Reilly, W., "Can Science Help Save Interior Wetlands?" *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 26-30.
74. Richardson, C. J., "Pocosin Wetlands" (Stroudsburg, Pa.: Hutchinson Ross Publishing Co., 1981).
75. Richardon, C. J., "Primary Productivity Values in Freshwater Wetlands," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 131-145.
76. Ryan, J. D., and Everitt, T., "Investigations of the Plant Community-Soil-Soil Strength Micromorphology Relationships in Coastal Marshes," NTIS No. AD-768 801, 1973.
77. Sander, J. E., "Electric Analog Approach to Bog Hydrology," *Groundwater*, vol. 14, No. 1, 1976, pp. 30-35.
78. Schamberger, M. L., Short, C., and Farmer, A., "Evaluating Wetlands as Wildlife Habitat," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 74-83.
79. Schitoskey, F., Jr., and Linder, R. L., "Use of Wetlands by Upland Wildlife," *Wetland Functions and Values: The State of Our Understanding*, P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 307-322.
80. School of Forestry and Environmental Studies, "Wetlands Trends and Policies in North and South Carolina," Duke University, OTA contract study, August 1982.
81. Shaw, S. P., and Fredine, C. G., "Wetlands of the United States: Their Extent and Their Value to Waterfowl and Other Wildlife," Fish and Wildlife Service, U.S. Department of the Interior, Circular 38, 1956, p. 67.
82. Smardon, R. C., "Visual-Cultural Values of Wet-

lands," *Wetland Functions and Values: The State of Our Understanding,* P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 535-544.

83. Snyder, B. D., and Snyder, J. L., "Feasibility of Using Oil Shale Wastewater for Waterfowl Wetlands," U.S. Fish and Wildlife Service, Office of Biological Service, contract No. FWS 14-16-009-82-002, Fort Collins, Colo., 1982.
84. Stickney, R. R., Taylor, G. L., and White, D. B., "Food Habits of Five Young Southeastern United States Estuarine Sciaenidae," *Chesapeake Sci.,* vol. 16, 1975, pp. 104-114.
85. Tchobanoglous, G., and Culp, G. L., "Wetland Systems of Wastewater Treatment: An Engineering Assessment," University of California, Davis, 1980.
86. Thayer, G. W., Stuart, H. H., Kenworthy, W. J., Ustach, J. F., and Hall, A. B., "Habitat Values of Salt Marshes, Mangroves, and Seagrasses for Aquatic Organisms," *Wetland Functions and Values: The State of Our Understanding,* P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 186-199.
87. Thomas, T., "A Detailed Analysis of Climatological and Hydrological Records of South Florida With Reference to Man's Influence Upon Ecosystem Evolution," report to U.S. National Park Service, 1970, p. 82.
88. U.S. Army Corps of Engineers, Institute for Water Resources, "Analysis of Selected Wetlands Functions and Values," unpublished draft report 81D-01, 1981.
89. U.S Army Corps of Engineers, "Charles River Watershed, Massachusetts Natural Valley Storage Project, Design Memorandum No. 1, Hydrologic Analysis," New England Division, Waltham, Mass., 1976.
90. U.S. Fish and Wildlife Service, "Refuge Visitation Figures," available from Division of Refuge Management, Branch of Resource Management, 1981.
91. Valiela, I., Teal, J. M., and Sass, W. J., "Production and Dynamics of Salt Marsh Vegetation and the Effects of Experimental Treatment With Sewage Sludge," *Journal of Applied Ecology,* vol. 12, No. 3, 1975.
92. Vecchiolo, J., Gill, H. E., and Land, S. M., "Hydrologic Role of the Great Swamp and Other Marshland in the Upper Passaic River Basin," *Journal of the American Water Works Association,* vol. 54, No. 6, 1962, pp. 695-701.
93. Verry, E. S., and Boelter, D., "Peat and Hydrology," *Wetland Functions and Values: The State of Our Understanding,* P. E. Greeson, J. R. Clark, and J. E. Clark (eds.) (Minneapolis, Minn.: American Water Resources Association, 1979), pp. 389-402.
94. Wadleigh, R. S., "Effects of Swamp Storage Upon Storm Peak Flows," M.S. thesis, Department of Agricultural Engineering, University of Massachusetts, Amherst, 1965.
95. Wayne, C. J., "Sea and Marshgrasses: Their Effect on Wave Energy and Nearshore Transport," M.S. thesis, Florida State University, College of Arts and Sciences, Tallahassee, Fla., 1975.
96. Weller, M., "Freshwater Marshes: Ecology and Wildlife Management" (Minneapolis, Minn.: University of Minnesota Press, 1981.
97. Wharton, C. H., "The Southern River Swamp—A Multiple Use Environment," Bureau of Business and Economic Research, School of Business Administration, Georgia State University, Atlanta, Ga., 1970.
98. Yonika, D., and Lowry, D., "Feasibility Study of Wetland Disposal of Wastewater Treatment Plant Effluent," final report, Commonwealth of Massachusetts Water Resources Commission, Research Project 78-104, 1979.
99. Zoltek, J., and Bayley, S. E., "Removal of Nutrients From Treated Municipal Wastewater by Freshwater Marshes," University of Florida Center for Wetlands, Gainesville, Fla., 1979.

# Chapter 4

# Wetland Programs That Affect the Use of Wetlands

WATERFOWL
PRODUCTION
AREA
OPEN
TO PUBLIC HUNTING

Photo credit: U.S. Fish and Wildlife Service

# Contents

*Page*

**Chapter Summary** . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 69

**Federal Programs** . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 69
Regulatory Permitting Programs . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 69
Acquisition and Incentive Programs . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 72
Other Environmental Programs and Policies . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 74
Assistance to States and Localities . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 75
Wetland Research Programs . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 76
Federal Programs That Affect Agricultural Conversions . . . . . . . . . . . . . . . . . . . . . . . . . . 77

**State Programs** . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 81
Wetland Regulation . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 81
Acquisition . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 82
Incentives to Landowners . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 82
Other Programs . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 82
State Influence on Federal Activities . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 82

**Local Programs** . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 83

**Private Initiatives** . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 84

**Chapter 4 References** . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 84

## Chapter 4

# Wetland Programs That Affect the Use of Wetlands

## CHAPTER SUMMARY

At this time, Federal policies do not deal consistently with wetland use. In fact, they affect wetland use in opposing ways. On the one hand, some Federal policies encourage wetland conversion by reducing the cost of converting wetlands to other uses, especially agriculture. On the other hand, some wetland use is controlled or managed through acquisition, easements, leases, regulation, and policy guidance. The U.S. Army Corps of Engineers' program to implement section 404 of the Clean Water Act (CWA) provides the major avenue for Federal involvement in controlling the use of wetlands through regulation. However, the 404 program regulates only the discharge of dredged or fill material; excavation, drainage, clearing, and flooding of wetlands are not covered explicitly. State and local programs as well as private initiatives also directly or indirectly affect the use of wetlands in a variety of ways.

The present administration's goals with respect to wetlands are unclear. On the one hand, the U.S. Army Corps of Engineers (the Corps) has revised its administrative procedures to reduce the regulatory burden on industry and to increase the role of the States. Some of these changes may have reduced the level of Federal control over wetlands use, although there will never be quantitative data to support this or any other statement made about the effects of these programmatic changes on wetlands. Administration support for State coastal management programs also has been reduced significantly, and no funds have been requested in the past 3 years for wetland acquisition. On the other hand, the Department of the Interior proposed a bill, Protect Our Wetlands and Duck Resources Act (POWDR). This bill proposed eliminating some Federal expenditures for some wetland activities, increasing funding to States for wetland conservation, extending the Wetlands Loan Act (due to expire in September 1984) for 10 years, and increasing revenues for the Migratory Bird Conservation Fund through additional fees for duck stamps and wildlife refuge visitation permits.

## FEDERAL PROGRAMS

The use of wetlands in the United States is affected either directly or indirectly by a large number of Federal, State, local, and private programs. This section briefly describes these programs, with emphasis on the more important Federal programs.

### *Regulatory Permitting Programs*

#### Section 404

Section 404 of CWA, as amended in 1977 from the Federal Water Pollution Control Act (FWPCA), is the primary means of Federal involvement in controlling the use of wetlands. In brief, persons seeking to conduct activities that would result in the discharge of dredged and fill material into "waters of the United States" first must apply for and obtain a permit from the local district office of the Corps. Some activities are specifically exempted; others are covered by general permits that require no applications for individual permits.

There are fundamental differences in the way Federal agencies and various special interest groups interpret the intent of section 404, which as stated in the preface to CWA, is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters.''[1] The Corps views its primary function in carrying out the law as protecting the quality of *water*; habitat and other wetland values, although considered in Corps decisions about projects, are usually of secondary concern. In contrast, Federal resource agencies, such as the U.S. Fish and Wildlife Service (FWS), the Environmental Protection Agency (EPA), the National Marine Fisheries Service (NMFS), and environmental groups feel that the mandate of CWA obliges the Corps to protect the integrity of *wetlands*, including their habitat values.

The Corps uses three general criteria for evaluating permit applications in a ''public interest review:''

- the relative extent of the public and private need for the proposed structure or work;
- the desirability of using appropriate alternative locations and methods to accomplish the objective of the proposed structure or work; and
- the extent and permanence of the beneficial or detrimental effects that the proposed structure or work may have on the public and private uses to which the area is suited.

It is unclear what consideration would be given to cumulative impacts under new regulations promulgated in 1982, which still include language recognizing that such impacts often result in major impairments of wetland resources.[2]

Until the 1982 changes, regulations stated that no permit would be granted for activities that involved the alteration of wetlands identified as important ''unless the benefits of the proposed alteration outweigh the damage to the wetlands resource and the proposed alteration is necessary to realize those benefits.'' The district engineer's determination of the necessity of the alteration must be based on whether the activity is ''primarily dependent on being located in, or in close proximity to, the aquatic environment or whether practicable alternative sites'' are available. Permit applicants must supply sufficient information on the need to locate the project in the wetland and on the availability of alternate sites.[3] The 1982 revisions to the Corps regulations eliminate the clause that the proposed alteration be necessary to realize benefits.

The assertion of regulatory jurisdiction of the Corps under the 404 program has changed over time, and further changes presently are being debated. Originally, jurisdiction was restricted to navigable waters, narrowly defined, and covered relatively few wetlands. A series of court decisions, especially the 1975 decision in *Natural Resources Defense Council* v. *Callaway*, expanded the scope of coverage to include virtually all waters of the United States, including most if not all wetlands.* However, congressional amendments to CWA and Corps regulations implementing the act have set limits to the jurisdiction of the 404 program.

The 404 program currently covers activities resulting in dredged and fill material discharges, with the following exemptions specified in the 1977 amendments to CWA:

- normal farming, silviculture,** and ranching activities, such as plowing, seeding, and cultivating; minor drainage; harvesting for the production of food, fiber, and forest products; or upland soil- and water-conservation practices;
- maintenance, including emergency reconstruction of recently damaged parts of currently serviceable structures such as dikes, dams, levees, groins, riprap,*** breakwaters, causeways, bridge abutments or approaches, and transportation structures;
- construction or maintenance of farm or stock ponds or irrigation ditches, or the maintenance of drainage ditches;
- construction of temporary sedimentation basins on a construction site, but excluding placement of fill material into navigable waters;

---

[1] Clean Water Act, sec. 101(a).

[2] Clean Water Act, sec. 320.4(b)(3).

[3] Clean Water Act, sec. 320.4(b)(4).

*On July 25, 1975, the Corps of Engineers published revised regulations redefining ''navigable waters'' to include: ''coastal waters, wetlands, mudflats, swamps, and similar areas; freshwater lakes, rivers, and streams that are used, were used in the past, or are susceptible to use to transport interstate commerce, including all tributaries to these waters; interstate waters; certain specified intrastate waters, the pollution of which would affect interstate commerce; and freshwater wetlands, including marshes, shallows, swamps and similar areas that are contiguous or adjacent to the above described lakes, rivers and streams, and that are periodically inundated and normally characterized by the prevalence of vegetation that requires saturated soil conditions for growth and reproduction.''

**Tree farming.

***Shoreline protection usually composed of broken stones.

- construction or maintenance of farm or forest roads, or temporary roads for moving mining equipment, where such roads are constructed and maintained in accordance with best management practices to assure that flow and circulation patterns and chemical and biological characteristics of the navigable waters are not impaired, that the reach of the navigable waters is not reduced, and that any adverse effect on the aquatic environment will be otherwise minimized;[4] and
- congressionally approved projects that have filed an environmental impact statement (EIS).[5]

In addition to these exemptions, a large number of activities fall under general permits. General permits are promulgated to increase the manageability of the 404 program at nationwide, regional, and State levels for activities deemed by the Corps to have minor impacts on waters of the United States. Persons conducting such activities need not apply for individual permits; however, in many cases, they are expected to follow specified practices to minimize further the impacts of their actions. As of late 1981, the Corps had issued 374 general permits, which has reduced the number of permit applications by an estimated 60,000 to 90,000 annually.

The 404 program also regulates certain geographic areas with less stringency than other areas. Prior to the 1982 regulatory changes, activities in wetlands that are not linked to a tributary system, above the headwaters of tributary streams (above a point where the mean annual streamflow is less than 5 cubic feet per second ($ft^3/s$)), or less than 10 acres in surface area did not require individual permits as long as certain environmental safeguards were complied with. The 1982 regulations expanded these exempted areas to include any isolated wetland regardless of size. Subsequent proposals published on May 12, 1983, reinstated this limitation.

Several Federal agencies besides the Corps have roles in the implementation of the 404 program. The Environmental Protection Agency (EPA), NMFS, and FWS review permit applications and provide comments and recommendations on whether permits should be issued by the Corps. EPA has the authority to veto any application or overrule any disposal site designated on a permit reviewed by the Corps if it finds project impacts unacceptable. It also develops criteria for discharges and State assumption of the 404 program.

Under memoranda of agreement (MOA) formerly in effect between the Corps, FWS, and NMFS, either NMFS or FWS representatives could request "elevation" of a permit for review at upper levels in the agency if there is disagreement about whether or not a permit should be granted by a district engineer. Though only infrequently carried out, elevation could greatly lengthen the permitting process, and resource agencies could use the threat of elevation to gain concessions from permit applicants. New MOAs signed in mid-1982 greatly restrict the power of FWS and NMFS to elevate permits, in particular by making elevation subject to concurrence by the Assistant Secretary of the Army (Civil Works), the head of the Corps.

As discussed below, States also have a role in the 404 program. States veto permit applications by denying certification through section 401 of CWA and may administer portions of the 404 program if they meet criteria established by EPA. Twelve States are evaluating this possibility of assuming 404 responsibilities and four have assumed partial responsibility for the program on a trial basis. In general, most States neither have the capability nor the desire to assume sole responsibiity for regulating wetland use without additional resources from the Federal Government; some States would be reluctant to do so even with resources.

In line with administration objectives to reduce the regulatory burden on industry and to increase the role of the States, the Corps revised many of its administrative procedures in 1982. Among other changes already mentioned, the normal permit-processing time was limited to 60 days for typical projects, 90 days for controversial projects. The use of general permits was expanded to include *all* (and not some) isolated waters and headwater areas. Statewide general permits are being used to transfer additional permitting responsibility to States. Sixteen environmental organizations sued the Corps in December 1982 on the basis of many of these changes. Most issues of concern to environmentalists were settled out of court in February 1984.

---

[4] Clean Water Act, sec.404(f)(1)(A)-(D).

[5] Clean Water Act, sec.404(r).

On May 12, 1983, the Corps proposed additional changes to its 404 regulatory program. Many proposals simply formalize many of the administrative changes that already have been made to streamline the permitting process. Other provisions involve fairly major changes. Two provisions appear to increase the level of wetlands regulation. First, a limitation of the use of nationwide permits to isolated waters to water bodies smaller than 10 acres in size, which was removed on July 22, 1982, was reinstated. Second, the Corps' authority to condition permits using either onsite or offsite mitigation measures was expanded. Three provisions appear to decrease the level of wetlands regulation by using "letters of permission," rather than permits, for minor discharges; by explicitly shifting the "burden of proof" to the Federal Government by presuming that an applicant's proposal is acceptable unless demonstrated by the Government not to be; and by expanding the use of nationwide permits in lieu of a case-by-case project 404 review to *all* Federal projects and private projects that are adjacent to Corps civil works projects.

### Section 10, Rivers and Harbors Act

Under the Rivers and Harbors Act of 1899, permits from the Corps are required for dredge, fill, and other activities that could obstruct navigable waterways, defined as those waters below the ordinary or mean high-water level or tide level. Prior to 1968, the Corps considered only potential impacts of such activities on navigation. In 1968, permit criteria were broadened to include evaluation of fish and wildlife, conservation, pollution, esthetics, ecology, and the general public interest, as well as navigation. These criteria have been broadened further to include additional factors, including economics, historical values, flood damage prevention, recreation, water supply, water quality, energy needs, and food production. Some of these criteria favor wetland protection, while others support development.

Often, section 10 and section 404 permitted activities are processed concurrently. Although wetlands covered by section 10 also are covered by section 404, and although wetland protection is not a stated goal of section 10 permitting, section 10 has served to protect wetlands against some impacts that are not dealt with by section 404 permitting. Unlike section 404, section 10 does not exempt any activities from coverage.

## *Acquisition and Incentive Programs*

As of September 30, 1981, FWS administered, through ownership, lease, or easement arrangements, close to 89 million acres of land in the National Wildlife Refuge System, Waterfowl Production Areas, and coordination areas. Of this total, FWS estimates that approximately 33.4 million acres are wetlands, 28.7 million acres of which are in Alaska. The National Forest Service is responsible for managing about 190 million acres of land in the National Forest System, a small percentage of which is wetland. Aside from some special appropriations, primary funding for the Nation's acquisition and incentive programs comes from four sources.

### Migratory Bird Hunting and Conservation Stamps

Since 1934, FWS has sold Migratory Bird Hunting and Conservation Stamps, commonly known as "duck stamps," which must be purchased by waterfowl hunters aged 16 and older. Nonhunters may also purchase stamps. Since 1979, stamps have cost $7.50 per year; about 2 million are sold annually. Proceeds are used to acquire habitat for migratory birds. From the inception of the program to June 1982, more than 83 million stamps were sold, worth over $240 million and accounting for the purchase of more than 2.5 million acres of waterfowl habitat, a large portion of which is wetland.

### Wetlands Loan Act

A related source of funding is the Wetlands Loan Act of 1961, which provides for interest-free loan advances toward wetland acquisition and easements. A total of $200 million has been authorized by this program, out of which approximately $147 million has been appropriated through fiscal year 1983. This program is due to expire September 30, 1984, after which appropriations from the loan fund

*Photo credit: U.S. Fish and Wildlife Service, David B. Marshall*

Over $240 million worth of "duck stamps" have been sold to hunters since the program's inception in 1934, financing the purchase of more than 2.5 million acres of waterfowl habitat

are to be repaid with duck stamp receipts. Bills pending in Congress seek to extend this act.

### The Land and Water Conservation Fund Act

The Land and Water Conservation Fund Act (LWCF) of 1965 funds the purchase of natural areas, including wetlands. FWS has used this source of funding to protect endangered species and important natural resource areas and to extend the National Wildlife Refuge System. From fiscal years 1967 through 1982, FWS used approximately $182 million of LWCF money to acquire some 221,000 acres of land, an unknown portion of which are wetlands. The National Park Service also has used this source of funding for land purchases: from fiscal years 1965 through 1982, a total of $1.7 billion in outlays for 1.4 million acres were made. As with FWS outlays, information is not available on what proportions of these outlays and acreage pertain to wetlands.

### Water Bank Program

The Agriculture Stabilization and Conservation Service of the U.S. Department of Agriculture (USDA) administers the Water Bank Program. Authorized by the Water Bank Act of 1970, the objectives of the program are:

> To preserve, restore, and improve the wetlands of the Nation, and thereby (1) conserve surface waters, (2) preserve and improve habitat for migratory waterfowl and other wildlife resources, (3) reduce runoff, soil, and wind erosion, (4) contribute to flood control, (5) contribute to improved water quality and reduce stream sedimentation, (6) contribute to improved subsurface moisture, (7) reduce acres of new land coming into production and to retire lands now in agricultural production, (8) enhance the natural beauty of the landscape, and (9) promote comprehensive and total water management planning.

While agreements have been in effect in 15 States, the program is concentrated in the prairie-pothole region of Minnesota, North Dakota, and South Dakota. Through the Water Bank Program, private landowners or operators receive annual payments in exchange for agreeing not to drain, fill, level, burn, or otherwise destroy wetlands and to maintain grassy cover on adjacent upland.

With technical assistance from USDA's Soil Conservation Service (SCS) landowners and operators enter into 10-year agreements with the Secretary of Agriculture specifying requirements placed on land use and rates of compensation. Compensation varies with geographic area. Payments for wetlands usually range from $5 to $10/acre; such payments in California can range up to $22/acre. Payments for adjacent cropland generally range from $14 to $55/acre.

Payment rates are subject to review after 4 years and at the time agreements are renewed. For the first group of contracts coming up for renewal, the rate of renewal has been 50 to 60 percent. Agreements are transferable when land is sold and may be canceled by returning all previous payments. To be eligible for the program, land must be privately owned inland-wetland areas of a certain type and size that "in the absence of inclusion in the program, a change in use could reasonably be expected which would destroy its wetland character." Other eligible land includes privately owned land, adjacent to eligible wetlands, which is essential for the nesting, breeding, or feeding of migratory waterfowl. Normally, in order to be eligible for participation, landowners must agree to designate a total of at least 10 acres in a conservation plan developed in cooperation with the soil and water conservation district in which the farm is located. Acreage can be less than 10 acres upon recommendation from SCS. The designated acreage must contain sufficient adjacent land for protecting the wetland and must provide essential habitat for the nesting, breeding, or feeding of migratory waterfowl.

From program inception in 1972 through 1982, congressional appropriations totaled over $100 million, with a little over 185,000 acres of wetlands and 480,000 acres of adjacent lands being covered by the 6,000 plus agreements that have been signed. Appropriations in 1982 were $8.8 million.

## *Other Environmental Programs and Policies*

### Executive Order 11990

Promulgated in May 1977, Executive Order 11990, Protection of Wetlands, mandates that each Federal agency in carrying out its individual responsibilities take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. This order specifically requires that agencies avoid undertaking or assisting new construction in wetlands unless no practicable alternative exists, that all practical measures to minimize harm to wetlands are included in the action, and that agencies consider a proposal's effect on the survival and quality of wetlands. The examples that follow, while not directed at wetlands per se, have had some effect in protecting wetlands.

### Executive Order 11988

Promulgated in May 1977, Executive Order 11988, Flood Plain Management, requires each Federal agency to avoid direct or indirect support of flood plain development wherever there is a practical alternative. Agencies are charged with the responsibility of providing leadership in restoring and preserving the beneficial values of flood plains and in reducing the risk of flood loss and the impact of floods on human welfare. Insofar as many wetlands are located in flood plains, this order could influence much wetland development.

Executive Orders 11990 and 11988 apply to such Federal activities as construction projects, acquisition and disposal of lands, and grants in aid and technical assistance to States and localities for such activities as land and water planning and the building of roads, sewers, and water supply systems. They do not apply to federally permitted or licensed activities on private property. Most Federal agencies have issued regulations to implement the orders in interim or final form; however, several sources believe that they have had little impact on wetland losses. However, by helping to educate people to the values of wetlands, these Executive orders may indirectly have influenced Federal Government decisions about wetlands use.

### Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act, as amended in 1958, requires that wildlife conservation be given consideration equal to the concern for other aspects of the water resource development projects of the Corps, Bureau of Reclamation, and other Federal agencies. This act has empowered FWS and the NMFS to evaluate the impact on fish and wildlife of all new Federal projects and federally permitted projects, including projects permitted under section 404. FWS and NMFS have used their authority under this act to attempt to limit adverse impacts of projects on wetlands.

### Endangered Species Act

The Endangered Species Act of 1972 prohibits any Federal agency from undertaking or funding a project that will threaten a rare or endangered species. As many such species depend on various wetlands, some wetland development is restricted de facto by this statute.

### National Environmental Policy Act

The National Environmental Policy Act (NEPA) of 1969 provides that EISs be prepared for Federal activities and federally permitted activities that would have significant environmental impacts. EISs must address such things as the environmental impact of the proposed action, any adverse environmental effects that cannot be avoided if the action is implemented, and alternatives to the proposed action. While NEPA does not prohibit or otherwise constrain Federal actions once an EIS has been prepared, the process of EIS preparation makes it more likely that project impacts and ways of lessening impacts will be considered. NEPA reviews have been applied to many projects suspected of posing substantial impacts to wetlands.

### National Pollution Discharge Elimination System (NPDES)

Section 402 of CWA authorizes a national system for the regulation of point sources of pollutants into the waters of the United States, with regulation by either EPA or through approved State programs. Some discharges into wetlands have been controlled through NPDES permitting.

## *Assistance to States and Localities*

### Development and Operation of Regulatory Programs

Several sources of Federal funding have been available to assist States, and in some cases localities, to develop and administer regulatory programs that may include wetland protection features.

The *Coastal Zone Management* (CZM) program is an example of a program not directed primarily at wetlands in which the Federal Government and the States mutually influence one another's wetland-related activities. Pursuant to the Coastal Zone Management Act of 1972, the Federal Office of Coastal Zone Management (OCZM) sets guidelines and provides funding for States to prepare CZM programs. Approval of a State CZM program after review by OCZM enables a State to receive further funding for program implementation. States have used such funding to hire personnel, monitor and enforce CZM regulations, and provide technical assistance to localities, among other purposes. Federal guidelines for State programs include provisions that impacts on wetlands be considered. Annual reviews of State programs are carried out by OCZM and include review of how wetlands are being treated in programs. Federal influence is exercised through the granting or withholding of program approval and the concommitant disbursement of funds. States, of course, may forego Federal guidelines, review, and funding and design and/or implement their own CZM programs. State influence through CZM programs over Federal activities, such as the granting of 404 permits, is discussed later in this section.

### Technical Assistance and Grants in Aid

Federal funding and technical assistance to States and localities may be used for purposes directly protecting wetlands. Conditions attached to Federal aid used for other purposes may indirectly support wetlands protection. For example, through the *Federal Aid to Wildlife Restoration Act* of 1937 (Pittman-Robertson Act), FWS provides grants to States for up to 75 percent of the cost of projects for the acquisition, restoration, and maintenance of wildlife areas, including wetlands. Grants are drawn from an 11-percent Federal excise tax on the sale of firearms and ammunition. Close to $1 billion has been given to States, which have acquired over 3.5 million acres, over 1.5 million of which are waterfowl areas.

*The Federal Aid in Fish Restoration Act* (1950) commonly known as the Dingell-Johnson Act, provides Federal assistance to States for projects pertaining to fish. The provisions of the Dingell-Johnson Act are parallel to those of the Pittman-Robertson Act. Funds derived from the Federal excise tax on fishing equipment and bait are apportioned annually among the States—40 percent on the basis of geographical area and 60 percent on the basis of the number of persons holding paid licenses to fish for sport or recreation. Funds so apportioned to the States are available for use by them for "fish restoration and management projects" or, since 1970, "comprehensive fish and wildlife resource management plans." The Federal share in the cost of such projects or plans is not to exceed 75 percent.

Through the *Land and Water Conservation Fund,* matching grants are given to States, counties, and localities for outdoor recreation purchases. From 1965 through the end of 1982, 137 projects involving 61,585 acres of wetlands were given $40.7 million from this funding source.

### Other Federal Assistance

The *National Flood Insurance Program* (NFIP) has indirectly encouraged the destruction or degradation of wetlands, especially in the past, by partially underwriting the risks of building in flood-prone areas, some of which may also be wetlands. However, this program now has rules in force that discourage building in areas of known flood risk and that lessen the impacts of development that does take place. For example, communities with mangroves that act as coastal flood-protective barriers must adopt regulations protecting the mangroves in order to qualify for insurance under the program. Fills are prohibited in some settings, and the use of piles or columns where the elevation of structures is necessary is encouraged. Although the Federal Emergency Management Agency does not itself regulate flood plain use, localities wishing to qualify for federally subsidized flood insurance must agree to adopt regulations meeting Federal standards. More than 17,000 communities have adopted or have indicated an intent to adopt flood plain regulations, and more than $35 billion in policies have been issued. Many communities now regulating wetland development do so through flood plain regulations designed not only to reduce flood problems but also to protect wetland functions. The NFIP very recently has begun acquiring areas that frequently are flooded.

## Wetland Research Programs*

While NMFS, EPA, FWS, the National Science Foundation (NSF), and other Federal agencies conduct wetlands research that is related directly to their respective missions, the Corps is the only Federal agency that has a program set up specifically for wetlands research. The Corps' wetland-research program is carried out primarily by the Waterways Experiment Station (WES).

A 5-year wetland research program was set up by the Corps to begin in 1982. Three research priorities are established for this program: 1) to develop improved and standardized techniques to assist Corps personnel in the field identification and delineation of wetlands, 2) to assess and quantify wetland values for use in evaluating permit activities, and 3) to develop techniques for wetland restoration in permafrost, freshwater interior, and coastal environment. Little research has been focused on evaluating the impacts of wetland loss.

Research on the field identification and delineation (mapping) of wetlands presently is being conducted, and the Corps expects to complete this phase of its research by 1985. The next focus for the research program is the quantification of the functional values of wetlands. Part of this research is underway. WES, for instance, already has completed an evaluation of techniques for assessment of wetland values, and they are currently in the process of assembling a data base of regional literature on wetland values. This data base will be combined with a similar base developed by FWS and then computerized to provide easy access to field personnel. In November 1983, the Corps conducted a workshop to discuss the future direction for research to quantify wetland values. The workshop was attended by Corps personnel at the district level as well as those at the Washington level. For fiscal year 1983, $620,000 was allocated to the Corps' wetland-research program.

While research that may pertain to wetlands may be conducted under FWS programs on endangered species, fisheries, and wildlife, the central research program at FWS—the Office of Biological Services (OBS)—allocates $400,000, or approximately 5 to 7 percent of its total funding, for wetland research. These funds are allocated to four research projects: 1) a computerized bibliography of literature on wetland values; 2) a list of wetland plants and soils (to aid in delineation); 3) a nearly completed assessment of the ecological impacts of disposing of wastewater on wetlands; and 4) an evaluation of mapping-display technology.

---

*Information for this section of the report was collected through personal communication with:

1. Ted Laroe—FWS Office of Biological Services (Mar. 23, 1983);
2. Herb Quinn—EPA's Office of Research and Development (Mar. 23, 1983);
3. Dr. Dean Parsons—National Marine Fisheries Service (Mar. 23, 1983);
4. Dr. Gary Barret—NSF's Biotic Systems Program (Mar. 25, 1983); and
5. Bill Kleshe—COE (Mar. 28, 1983).

At NMFS, approximately $6 million is slated now for "habitat research." About one-half of that amount is devoted to estuarine habitats, which would include all the NMFS research on wetlands. Half of the estuarine-related research is spent on ecological studies; the other half is spent on pollution-related studies. The research findings from both types of studies have a bearing on wetlands. Such research is carried out by regional centers, whose focus on wetland research depends on the priority of wetlands in the region. The Southeast Center probably conducts the most research on wetlands and at present is investigating the importance of wetland detrital flow into estuarine waters.

At EPA, the Office of Research and Development (ORD) is responsible for wetland research. ORD has a separate work unit set up for wetlands, but it is not funded at present. The approximately $300,000 allocated for water research by ORD includes wetland research.

NSF conducts basic research on wetlands through four different NSF programs, though primarily by the Biotic Systems Program, which conducts community-level studies (e.g., population studies), and the Ecosystem Studies Program, which is responsible for large ecosystem studies (e.g., an integrated analysis of the Okeefenokee Swamp). It is not possible to identify the funds spent on wetlands as opposed to other research areas. In 1978, NSF sponsored a workshop on research priorities for wetland-ecosystem analysis; the proceedings of this workshop were published and are available through the Environmental Law Institute.

The foregoing agencies all appear to have some more or less formal means of establishing *intraagency* research priorities. NMFS, for instance, develops a strategic plan; FWS programs go through what they call a "research-needs identification process." However, there is no formal mechanism to provide for *interagency* coordination of research. All the agency representatives contacted said that there is a great deal of informal communication between agencies. In addition, in 1981, the agencies met in Kearneysville, W. Va., to discuss their respective plans for wetland research. Proceedings of this symposium were not published. Though coordination of research plans between the agencies is informal, research projects have been sponsored jointly. Current joint studies are being conducted between NMFS and the Corps, between FWS and EPA, and between the Corps and FWS.

## Federal Programs That Affect Agricultural Conversions*

In the past, Federal programs encouraged the direct conversion of wetlands to agricultural use. Although funding of this type has been eliminated and policies to prevent alteration of wetlands have been established in some agencies, implementation of such policies has not been entirely effective. The other programs that still reduce the costs and risks associated with conversion include: income tax provisions, and to a limited extent, cost-sharing and technical-assistance programs for conservation practices sponsored by USDA's Agricultural Stabilization and Conservation Service (ASCS) and SCS, loan programs of the Farmers Home Administration, disaster payments, and crop insurance and commodity programs. In some regions, these policies add to the clear profitability of wetland conversion only if crop prices are sufficiently high. In other regions, wetland conversions may be unprofitable even with direct or indirect Federal assistance.

### Past Policies Encouraging Wetland Drainage

Between 1940 and 1977, USDA was authorized to assist landowners in draining their wetlands by providing both technical information and cost-sharing under the Agricultural Conservation Program (ACP). Between 1942 and 1980 nearly 57 million acres of wet farmland, including some wetlands, were drained under this program; most of this drainage occurred in the 1940's and 1950's. Minnesota had more land drained than any other State (over 5 million acres).

In 1962, Congress enacted Public Law 87-732 forbidding USDA from providing financial or technical assistance for wetland drainage in Minnesota, North Dakota, and South Dakota if the Secretary of the Interior found that wildlife preservation would be materially harmed by the drainage.[6] These findings were to be made on a farm-by-farm basis and to continue for 1 year unless a Government agency offered to purchase or lease the wetland. If such an offer was made but rejected by the landowner, the prohibition was to terminate 5 years after the Secretary of the Interior's finding.

---

*Discussion based on information gathered in OTA case studies and an OTA working paper on agricultural policies prepared by Ken Cook.

In 1977 President Carter issued Executive Order 11990 requiring all Federal agencies to minimize loss of all types of wetlands. As a result, ASCS cost-sharing for draining wetlands was eliminated in 1978. Also, SCS employees were limited officially in the technical information they could provide about wetland drainage.[7] More recent regulatory changes have been made that give SCS "additional flexibility in providing technical assistance to alter wetlands when denial of assistance could lead to detrimental consequences on soil and water resources or on human welfare and safety."[8] The rules strengthen the requirements to utilize all practicable measures to minimize impacts on wetlands resulting from SCS-assisted projects.[9]

When private drainage occurs, information by SCS may improve the efficiency of drainage. In addition, if SCS designs the drain, there is an opportunity that the constructed drain will affect only part of the wetlands while preserving the remainder. Technical information could aid in protecting wetlands in this way. Regardless of stated policy, however, it will continue to be difficult to control effectively the distribution of technical information about drainage.

Comments about the impacts of USDA cost-sharing on drainage varied. Those feeling that the impact was substantial cited the subsidy, stating that its elimination has to have an impact. Others feel that Federal and State governments still support drainage only in attitude. Information collected from OTA case studies suggests that Executive Order 11990 has probably not had a significant affect on drainage (2).

### Present Policies That Reduce Costs of Wetland Conversion

**Federal Income Tax.**—Numerous studies have pointed to Federal income tax writeoffs for all types of development activities as an important incentive to farmers to clear and drain wetlands for agricultural use. These provisions enable farmers to shift a portion of the investment costs of wetlands conversion to the general taxpayer. The incentives include:

- tax deductions from taxable income for land-clearing costs of up to $5,000 or 25 percent of taxable income (whichever is less);
- tax deductions of up to 25 percent of gross farm income for drainage expenses (expenses in excess of this allowable limit may be deducted in subsequent years);
- investment tax credit equal to 10 percent of the installation cost for drainage tile. This is a direct reduction of tax liability;
- tax deductions for depreciation on all capital investments necessary for any type of farming, including draining and clearing for bottom land farming, up to 5.5¢ per dollar invested if the investments have an expected life of 7 years of more; and
- deductions for interest payments.

Several researchers have provided examples of how these tax provisions can lower the cost of wetland conversion to farmers. Using 1978 cost estimates developed by Shulstad and May (5), Shabman (4) has calculated that the application of tax provisions could lower the cost of bottom land clearing in east Arkansas by about 30 percent (e.g., from $311.67 to $218.17/acre). Shabman further calculated in a hypothetical example that a farmer in a 30-percent tax bracket, who financed this conversion with a 20-year loan at a 10-percent interest rate effectively could reduce that interest rate to 7 percent and his annual loan payments from $36.60 to $20.59 over the period of the loan, "a significant (44 percent) reduction in cash-flow needs."

Barrows, et al. (1), performed a similar analysis of the effects of some tax policies on drainage costs in Wisconsin and came to similar conclusions. Without the tax incentives—the soil- and water-conservation deduction for drainage costs, the depreciation for drainage tile, and the investment tax credit for the tile—the increment to income for each drained acre would be considerably lower for farms with taxable household incomes in the $12,000 to $20,000 range. The value of the tax incentives increases as income rises, up to a certain level that easily is exceeded by large farming enterprises.

---

[6] 16 U.S.C. S.590, p. 1.

[7] 7 CFR, pt. 650.26.

[8] 7 CFR, pt. 650-Summary.

[9] *Federal Register*, vol. 44, No. 147, July 30, 1979—650.26(c) (2) (i) (B) and (C).

Partial budgets were used in a detailed study of drainage costs in Minnesota (6). The budgets included gross returns, production costs, and amortized drainage costs. Drainage costs ranged from $35 to $260/acre, depending on the size of the wetland and topography. Annual net returns in the prairie-pothole region varied considerably, with a high of $29 to a loss of $10/drained acre. Inclusion of property-tax effects (including Minnesota's tax credit) and State and Federal income taxes were occasionally large enough to offset a before-tax loss on the drainage investment. In the prairie-pothole region, net returns per year after taxes generally ranged from $0 to $20/acre. Income tax generally had the effect of reducing losses where before-tax returns were negative, and decreasing gains in areas where before-tax returns were positive. Deductions for drainage costs are taken prior to the returns from future commodities grown on the drained area, thereby resulting in a positive effect in early years (2).

**Cost-Sharing and Technical Assistance.**—The USDA ACP provides payments to farmers of up to 80 percent of the cost of construction of a wide variety of conservation practices. Practices for which cost-sharing is offered are developed by farmer-elected committees at the county level in consultation with county program development groups and are subject to the approval of a State committee. Other Federal programs such as the Great Plains Program provide similar assistance on a regional basis. Many States also have programs that may cover a portion of the non-Federal costs for projects supported by Federal cost-sharing programs.

Although direct drainage of wetlands is not funded under ACP, eligible practices for funding by these programs include actions that can lead to wetland drainage and filling. For example, in Nebraska, eligible practices for irrigation water conservation include dugouts, reuse pits, land leveling, irrigation ditch lining, and underground piping. Restrictions on the use of these Federal funds for wetland conversion include prohibitions on funding activities with the primary purpose of bringing new lands under irrigation, such as changing the surface area or depth of some types of wetlands and installing systems where the bottom of the pit is below the ground water surface. However, implementation of these provisions is difficult.

Administering agencies and their local agents have considerable discretion in interpreting and applying these restrictions. Program restrictions are particularly difficult to implement in areas such as the Rainwater Basin where the condition of wetlands varies from year to year, depending on seasonal and annual precipitation. Decisionmakers may be under considerable pressure from their neighbors to approve a project and to determine that an area is not a wetland. Available evidence and discussions with many people indicate that some cost-sharing still is used for wetland drainage. However, it generally is agreed that the implementation of the cost-sharing programs are increasingly responsive to policies to protect remaining wetlands (3). In fact, many thousands of acres of wetlands have been created or improved with technical assistance from SCS.

The importance of cost-sharing assistance in a farmer's decision to convert wetlands was analyzed in OTA's Nebraska case study (3). It provided an analysis of the profitability of the different conversion activities in Nebraska and concluded that most conversions have questionable profitability. Government cost-sharing of $19.86/acre/yr for producing irrigated corn on wetlands drained with the installation of a reuse-pit system resulted in a 16-year average annual net revenue per acre of $30.32, versus $10.46 without Government cost-sharing. Production of irrigated corn on smaller, shallower wetlands that could be filled by leveling was the most profitable at $57.24 for the same period of time with Government cost-sharing assistance of $5.88/acre/yr. These returns were considered to be modest. However, even with the Government cost-sharing, a farmer would have lost money in 2 of the 16 years investigated, and profits would have been less than $10/acre in 3 additional years. Without Govern-

ment assistance, the farmer would have lost money in 5 of the 16 years investigated, and profits would have been less than $10/acre in 4 additional years.

Using economic multiplier analysis, the Nebraska study then estimated the impact on the State economy of investment expenditures made to drain and convert wetlands for expanded agricultural use and of new crop production resulting from this conversion. Based on estimates of the annual wetland acreage lost each year and on the types of profitable conversions that occurred in the Rainwater Basin, the study concluded that the income resulting from converting wetlands in the Rainwater Basin to irrigated corn is less than 0.000072 percent of State personal income and around 0.000056 percent of the personal income in the 17-county Rainwater Basin area.

Other examples of converting Rainwater Basin wetlands to irrigated alfalfa with reuse systems and to dryland wheat farming resulted in losses in net annual revenue per acre over the 16-year average, regardless of Federal cost-sharing assistance.

**Farmers Home Administration Loans.**—Programs administered by the Farmers Home Administration (FmHA) have been noted as having a potentially adverse effect on wetlands. For example, FmHA personnel stated in interviews with an OTA contractor that FmHA operating loans have been used for wetland conversion even in the recent past. FmHA agrees that wetland conversions should not be financed through FmHA, but there are practical problems in implementing such a policy. FmHA published draft regulations to comply with Executive Order 11990 and other environmental laws in 1982. These regulations, when finalized, will disallow approval or funding of any proposals that would directly or indirectly result in conversions of wetlands. Implementation is expected to vary between States and counties, since decisionmakers at the State and local levels have broad discretion in making a loan decision. Although loan applicants may be required to have SCS farm-conservation plans that would provide for the protection of wetlands, it is not clear to what extent the farm plans will have to be implemented to receive FmHA assistance.

**Federal Disaster Payments and Crop Insurance.**—Recent congressional and USDA policy changes exclude high-risk areas from disaster payments and subsidized crop insurance. Specific areas that are excluded from coverage are being mapped in each county. Although wetlands are not specifically excluded from coverage under the program (the Federal Crop Insurance Agency that administers the program hasn't issued regulations for complying with Executive Order 11990), areas such as wetlands that are subject to unacceptably high risks from flooding or excess moisture generally are excluded. If an area is subject to flooding as frequently as every 4 to 5 years, it is unlikely to receive either disaster payments or subsidized crop insurance. In some areas of the country, for instance, especially the Missouri and Mississippi River Basins, certain flood plain and wetland areas are excluded from coverage because of the high risk of crop loss to flooding. Also, some wetlands in Minnesota are excluded because of the high risk of summer flooding.

**Commodity Programs.**—While the actual impact of price supports and target prices have probably not been significant in encouraging wetland conversions, they have been criticized for the following four reasons.

1. Commodity programs have the potential to increase crop prices above the level that would prevail without the programs. These artificially high prices might encourage farmers to increase their amount of land in crops by converting wetlands. However, these artificially high prices still are relatively low and only go into effect when market prices drop to the average cost of production. Even with the artificially higher price, a farmer with average production costs is unlikely to be in a financial position to undertake costly conversions. However, because larger farmers may have production costs lower than the national average and are more likely to participate in the commodity programs, commodity programs may aid some larger farmers in their conversion efforts.

2. Commodity programs reduce the risk associated with growing certain crops. Guaranteed floor prices may improve the long-term financial feasibility of converting wetlands and make agricultural lenders more willing to finance conversion operations. In the case of soybeans, which have only a floor price and not the other features of commodity programs for other crops, market prices have until very recently remained well above the floor price, and the program hardly has been used.
3. Commodity programs for most crops (not soybeans) set restrictions on the acreage that a participating farmer can plant in a particular crop each year. Usually the farmer must not plant about 10 percent of his "normal crop acreage" (NCA). However, NCA can be increased by draining wetlands, allowing the farmer to plant more acreage in the future. Although a farmer who planted more than the allowable acreage in a particular year would not be eligible for commodity payments that year (e.g., by converting wetlands), his NCA would be increased in subsequent years. However, for the 1983 farm program the Congress mandated that commodity payments would generally be based on the acreage planted in the preceding year. Therefore, no lands that were added to production in 1982 are included in NCA this year. It is expected that farmers will be able to increase their acreages sometime in the future.
4. Commodity programs (at least in the past) encouraged land management practices that may have adverse impacts on wetlands. For example, summer fallow for wheat can result in erosion that fills in surrounding wetlands. In 1977, Congress required proper soil conservation measures on summer-fallow acreage eligible for the wheat program. However, as with other commodity programs, few farmers participated until recently, when crop prices dropped. Thus, many farmers may not be following conservation practices on summer fallow.

# STATE PROGRAMS

States vary greatly in their approaches and attitudes toward wetland protection. Even within States, different agencies may take different positions on wetland protection and development—e.g., as with Federal entities, State environmental agencies and State transportation and water-resource agencies often find themselves in disagreement. The direction of State programs is open to change by reason of changes in political leadership and changes in State fiscal health, among others. Despite these caveats, a number of observations may be made about State wetland protection efforts.

## *Wetland Regulation*

More than a dozen States have permitting programs specifically directed at controlling the use of wetlands. Most of these programs are administered directly by State agencies, although local governments may be given the authority to veto approval of some projects. A few States have State standard-setting for regulation. Local governments formulate, administer, and enforce regulations meeting or exceeding wetland protection set by the State. In States where local programs dominate, the States may retain the authority to review local decisions or to intervene only where localities fail to create adequate controls. States also may provide technical assistance to local program administrators.

A few States have established innovative regulatory programs for wetland protection that differ from the more typical permit or zoning approaches. For example, in Massachusetts, the Coastal and Inland Wetland Restriction Acts place deed restrictions on wetland property to limit use to water-related uses such as docks, recreation, farming, and driveways into unrestricted land. Thus far, over 40,000 of the estimated 60,000 acres of coastal wetlands have been subjected to the law and only 5,000 acres of inland wetlands have been restricted. Another example of an innovative program is the Minnesota Protected Waters Program and its relationship with the Minnesota Water Bank Program. Permits for drainage are required but automatically are denied for wetlands identified as protected waters (i.e., wetland types 3, 4, and 5, greater than 10 acres and 2.5 acres in unincorporated and incorporated areas, respectively). The landowner will be able to drain legally if within 60 days the State fails to offer some type of compensation. Without this offer, Minnesota case law would declare the rejection an illegal taking because the owner was not justly compensated. Acceptable offers, according to the statute, include State Water Bank payments, purchase, or indemnification by other means such as conservation restrictions, easements, leases, or any applicable Federal program. As discussed in more detail in chapter 9, State regulation of coastal wetlands is far more common than that of inland wetlands.

## Acquisition

Several States have programs that give priority to the acquisition of wetlands.

## Incentives to Landowners

Some States authorize tax relief for landowners to preserve wetland and other open-space areas. At least one State has a program resembling the Federal Water Bank Program. Under the Minnesota Water Bank Program, requirements for participation are more stringent than those for the Federal program (i.e., wetlands must be of such a nature that drainage would be lawful, feasible, and practical, that drainage would provide high-quality cropland, and that cropland is its projected use). Payment rates also are much higher under this State program than under the Federal program. In 1981, annual payments ranged from $85 to $125/acre.

## Other Programs

Many States control wetlands use through programs whose primary purpose is not wetlands protection. Types of programs include:

- coastal zone management,
- flood plain management,
- shoreline zoning,
- scenic and wild rivers protection,
- critical or natural areas protection,
- dredge and fill acts,
- wildlife and waterfowl protection,
- public lands management,
- public education,
- stream alteration requirements, and
- site location of developments.

## State Influence on Federal Activities

The Corps seeks good relations with State governments and usually will defer to strongly expressed State wishes concerning particular projects. In several Corps districts, the Corps will not act on a permit prior to a State decision about a project. In addition to these informal mechanisms, several legal requirements establish State influence in Federal wetland-permitting decisions.

### The Clean Water Act and Corps Regulations

Section 404(t) of CWA requires that each Federal agency comply with State requirements to control the discharge of dredged or fill material as long as such requirements do not affect or impair the authority of the Secretary of the Army (i.e., the Corps) to maintain navigation.

Section 320.4(j)(1) of the Corps regulations implementing section 404 states that the processing of applications for Corps permits normally will proceed concurrently with the processing of other required Federal, State, or local authorizations or certifications. If any of these other authorizations are denied, the permit application to the Corps also will be denied.* Even if such certification or authorization is not required by the governmental units concerned, the Corps will give due consideration to the comments and views of the State, regional, or local agency having jurisdiction or interest over the particular activity in question.[10] Similarly, the officially adopted State, regional, or local land use classifications, determinations, or policies that are applicable to the areas under consideration shall be considered by the Corps as part of the public interest review.[11]

---

*Prior to the July 1982 changes, this was stated directly at a different point: "Permits will not be issued where certification or authorization of the proposed work is required by Federal, State, and/or local law and that certification or authorization has been denied." (§320.4[j][5]). This section was eliminated by the 1982 revisions.

[10] Clean Water Act, sec. 320.4(j)(1).

[11] Clean Water Act, sec. 325(j)(2).

In cases where several agencies within a State comment on an application and conflict, and no agency has been designated to provide a single State position, the Corps will ask the State's Governor to designate such an agency to provide his/her views directly.[12] Finally, division engineers will refer permit applications to the Chief of Engineers in cases where the recommended decision is contrary to the stated (1982 revisions: written) position of the Governor of the State in which the work is to be performed.[13] The Corps generally will issue a permit following receipt of a favorable State determination unless it finds "overriding national factors of the public interest" that cause it to overrule the State permit decision.[14]

Section 401 of CWA provides that no Federal license or permit for an activity that may result in a discharge into navigable waters shall be issued unless the State in which the discharge originates certifies that such a discharge will comply with the provisions of CWA. The main application of this section is to 404-permit requests. Generally, the State agency responsible for water quality decides on certification. A few States use this section as their chief means of regulating wetland development.

### Coastal Zone Management Act

Section 307(c) of the Coastal Zone Management Act (CZMA) of 1972 requires that all Federal activities significantly affecting the coastal zones of States with CZM plans approved by the Secretary of Commerce be conducted in a manner consistent with such State CZM plans. In States with approved CZM programs, applicants for 404 permits must include in their application to the Corps a certification that the proposed activity complies with the State's program. If within a 6-month period the State agency responsible for coastal zone management informs the Corps that it does not concur in the applicant's certification of consistency, the Corps may not issue the permit, unless the Secretary of Commerce overrides that State's objection on grounds that the activity is consistent with the purposes of CZMA or is necessary in the interests of national security.

### Fish and Wildlife Coordination Act

Under the Fish and Wildlife Coordination Act and the Reorganization Plan No. 4 of 1970, any Federal agency that proposes to control or modify any body of water must first consult with FWS, NMFS, and the head of the appropriate State agency administering the wildlife resources of the State concerned. While the Act does not give State agencies a concrete power to veto or modify Federal proposals, it does mandate a certain level of State involvement in the consideration of many projects potentially affecting wetlands.

---

[12] Clean Water Act, sec. 320.4(j)(3).
[13] Clean Water Act, sec. 325.8(b)(2).
[14] Clean Water Act, sec. 320.4(j)(4).

## LOCAL PROGRAMS

In some areas of the country, the principal means of wetland protection outside of the 404 program come from local programs. Some localities have acquired wetlands directly or have included wetland parcels along with other land acquisitions for parks and other protected areas. In addition, some protection is afforded by local implementation of State or Federal regulations. For instance, State shoreland zoning administered by localities in several States (e.g., Wisconsin) has provisions that protect wetlands. The National Flood Insurance Program, implemented in localities, has several features that have the effect of protecting wetlands.

Moreover, local building, sanitary, and other types of codes have had the effect of protecting wetlands in many localities. For example, wetlands are often poor locations for siting septic tanks or aboveground structures, and such uses may be prohibited by local codes. Several States have State standard-setting for local regulation (e.g., Virginia, Massachusetts, and Connecticut). Local zoning power also has been used to protect wetlands by providing for adequate open space and recreational areas.

## PRIVATE INITIATIVES

Many private organizations are involved in wetland protection. Private efforts such as those of the Nature Conservancy, Ducks Unlimited, and the Audubon Society, which have protected many thousands of acres of wetlands along with other types of natural areas through direct acquisition, partial interest, and other means. For example, the Richard King Mellon Foundation recently gave the Nature Conservancy a $25 million grant towards its efforts to conserve wetland ecosystems in the United States. Ducks Unlimited is another private organization interested in preserving wetlands for duck habitat. Many other national environmental organizations, while not directly managing wetland areas, carry out various activities (e.g., education) that help protect wetlands. Hundreds of other organizations on a local or regional level have been active in wetland protection, including fish and wildlife clubs, hunting organizations, and general or special purpose environmental organizations.

Recognizing that Federal acquisition of land or easements to meet FWS goals exceeds the Federal Government's fiscal capability at this time, POWDR group was formed by the Department of the Interior's former Secretary James Watt. It is composed of representatives from sportsmen's organizations, such as Ducks Unlimited and Bass Angler's Sportsmen's Society, and from corporations such as DuPont and Olin. The aim of the group is to advise public and private officials on wetlands protection and to encourage owners of wetlands, duck hunting clubs, and others to make gifts of their land or development rights on their land to private conservation groups, State agencies, or FWS.

## CHAPTER 4 REFERENCES

1. Barrows, R., Henneberry, D., and Schwartz, S., "Individual Economic Incentives, The Tax System and Wetland Protection Policy: A Study of Returns to Wetlands Drainage in Southeastern Wisconsin," American Society of Agricultural Engineers, summer meeting, 1982, p. 26.
2. Department of Agricultural Economics, "Wetlands in the Prairie Pothole Region of Minnesota, North Dakota, and South Dakota—Trends and Issues," North Dakota State University, contract study for OTA, August 1982, pp. 56-60.
3. Great Plains Office of Policy Studies, "Wetland Trends and Protection Programs in Nebraska," University of Nebraska, contract study for OTA, September 1982, pp. 49-55.
4. Shabman, L., "Economic Incentives for Bottomland Conversion: The Role of Public Policy and Programs," *Proceedings of Forty-Fifth North American Wildlife Conference*, 1980, pp. 402-12.
5. Shulstad, R. N., and May, R. D., "Cropland Conversion Study for the Mississippi Delta Region," report to Resources for the Future, Department of Agriculture Economics and Rural Sociology, University of Arkansas, Fayetteville, 1979, p. 181.
6. U.S Army Corps of Engineers, "The Economics of Wetlands Drainage in Agricultural Minnesota," St. Paul District, St. Paul, Minn., 1981.

## Chapter 5

# Wetland Trends

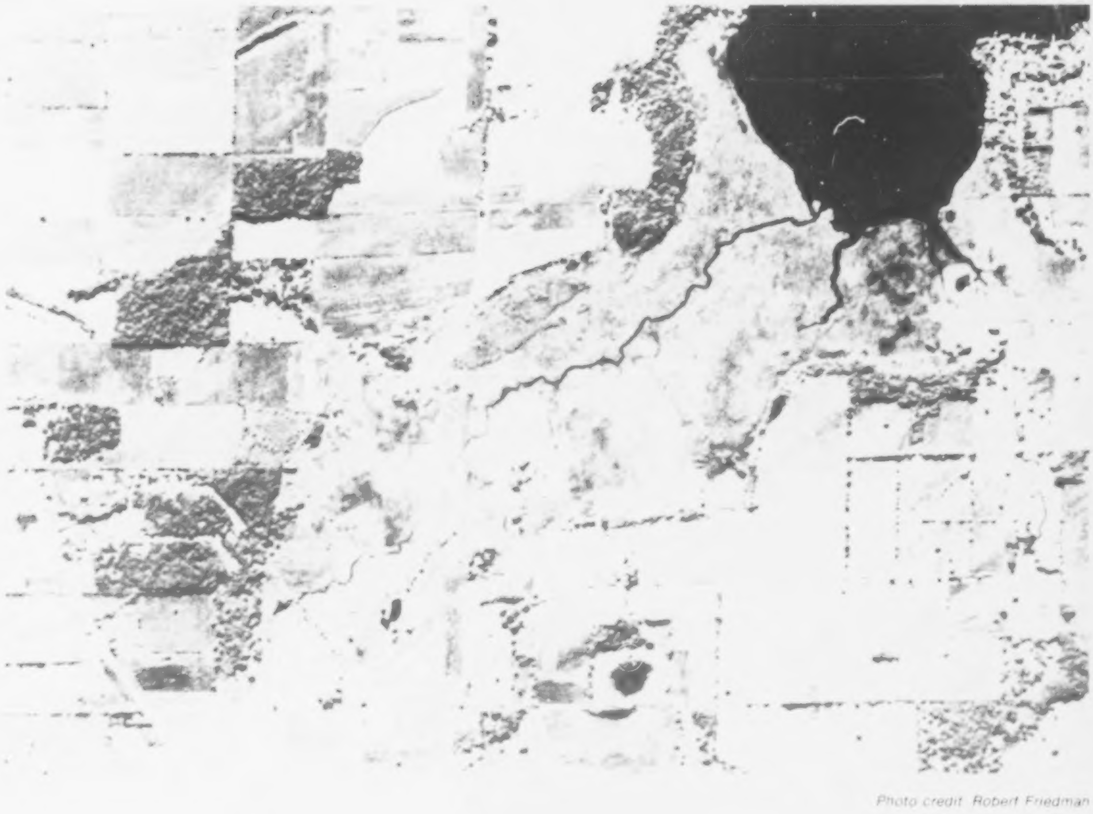


Photo credit: Robert Friedman

# Contents

Page

**Chapter Summary** .......... **87**

**National Trends—Net Loss and Gain** .......... **87**
Factors Affecting Wetland Loss .......... 88
Trend Information .......... 90

**Vegetated Wetland Trends** .......... **91**
Freshwater Wetlands .......... 91
Saltwater Wetlands .......... 93
Regional Trends .......... 94
Agricultural Conversions .......... 108

**National Trends in Agricultural Land Use** .......... **112**

**Chapter 5 References** .......... **113**

TABLES

*Table No.* — *Page*
11. Relationship Between Wetland Types Used for This Report .......... 88
12. Probable Causes of Freshwater Vegetated Wetland Changes .......... 92
13. Probable Causes of Saltwater Vegetated Wetland Changes .......... 94
14. Physiographic Regions Used for Regional Analysis of National Wetland Trends Study Data .......... 95
15. Pattern of Wetland Loss by Physiographic Region .......... 96
16. Percentage of Vegetated Wetland Loss to Different Uses by Physiographic Region .......... 97
17. Wetland Case Study Sites .......... 98
18. Agricultural Conversions of Wetlands .......... 100
19. Conversions of Wetlands to Open-Water and Deep-Water Environments .......... 102
20. Wetland Losses From Urban Development .......... 104
21. Wetland Losses From Other Activities .......... 106
22. Surface and Subsurface Drainage of Farmland, 1900-1980 .......... 109

FIGURES

*Figure No.* — *Page*
6. Changes in Wetlands Since the 1950's .......... 88
7. Freshwater Wetland Trends .......... 92
8. Saltwater Wetland Trends .......... 93
9. Physical Subdivisions .......... 95

# Chapter 5
# Wetland Trends

## CHAPTER SUMMARY

Within the last 200 years, 30 to 50 percent of the wetlands in the lower 48 States have been converted by activities such as agriculture, mining, forestry, oil and gas extraction, and urbanization. About 90 million acres are covered now by wetlands. According to the most recent Federal survey, approximately 11 million acres of wetlands in the lower 48 States were converted to other uses between the mid-1950's and mid-1970's. This amount was equivalent to a net loss each year of about 550,000 acres, or about 0.5 percent, of remaining wetlands. Present nationwide rates of wetland conversion are about half of those measured in the 1950's and 1960's. This reduction is due primarily to declining rates of agricultural drainage and secondarily to government programs that regulate wetlands use. While *coastal* wetlands are protected reasonably well through a combination of Federal and State regulatory programs, *inland*, freshwater wetlands, which comprise 95 percent of the Nation's wetlands, generally are not well protected.

Wetland conversion rates and activities vary significantly throughout the country. On the one hand, conversions in the Lower Mississippi River Valley occurred between the mid-1950's and mid-1970's at rates that were nearly three times the national average; on the other hand, rates in the Atlantic coast (exclusive of Florida) were only 30 percent of the national average. Overall, wetland conversions occurred in coastal areas at rates that were about 25 percent less than inland conversion rates.

Ninety-seven percent of actual wetland losses occurred in *inland*, freshwater areas during this 20-year period. Agricultural conversions involving drainage, clearing, land leveling, ground water pumping, and surface water diversion were responsible for 80 percent of the conversions. Of the remainder, 8 percent resulted from the construction of impoundments and large reservoirs, 6 percent from urbanization, and 6 percent from other causes, such as mining, forestry, and road construction. Fifty-three percent of inland wetland conversions occurred in forested acres, such as bottom lands. Of the actual losses of *coastal* wetlands, approximately 56 percent resulted from dredging for marinas, canals, port development, and to a lesser extent from erosion; 22 percent resulted from urbanization; 14 percent were due to dredged-material disposal or beach creation; 6 percent from natural or man-induced transition of saltwater wetlands to freshwater wetlands; and 2 percent were from agriculture.

## NATIONAL TRENDS—NET LOSS AND GAIN

According to the National Wetland Trends Study (NWTS) (8), conducted recently by the U.S. Fish and Wildlife Service (FWS), there were in the mid-1970's approximately 99 million acres of vegetated and unvegetated wetlands in the United States, exclusive of Alaska and Hawaii.* Saltwater (or estuarine) wetlands comprise 5 percent of the wetlands; the rest are freshwater wetlands. (See table 11 for the relationship between the wetland types described in this chapter and those discussed in ch. 1.) About 93 million acres are vegetated types, including areas dominated by emergent plants (emergent wetlands), large trees (forested wetlands), and shrubs and small trees (scrub/shrub wetlands). Between the mid-1950's and mid-1970's, there was a *net loss* of these vegetated wetlands of approximately 11 million acres (fig. 6). Ninety-seven percent of this net loss was attributed to freshwater wetlands.

---

*Alaska and Hawaii were not included in NWTS. However, the Alaska District of the Corps of Engineers estimates that there may be as many as 223 million acres of wetlands in Alaska, nearly 60 percent of the State. Almost half of this potential wetland acreage (98 million acres) is some type of tundra. Overall, the loss of wetlands in Alaska has not been great, although it has been concentrated in a few locations. Figures for Hawaii were not obtained but are expected to be quite low in relation to the data for the lower 48 states.

Table 11.—Relationship Between Wetland Types Used for This Report[a]

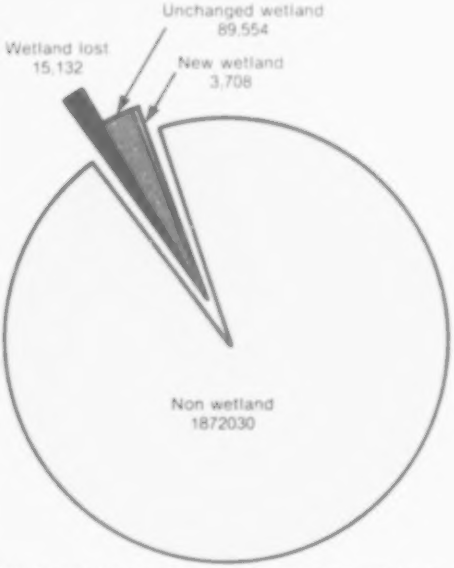
| NWTS wetland classification types discussed in this chapter | National Wetland Trends Study code | Wetland types discussed in chapter 2 |
|---|---|---|
| ***Estuarine (saltwater):*** | | |
| • Intertidal vegetated: | | |
| Emergents | 3 | Salt and brackish marsh (coastal) |
| Forested/scrub/shrub | 4 | Mangrove (coastal) |
| • Intertidal nonvegetated: | | |
| Unconsolidated shore | 5 | Mudflats (coastal) |
| Other | 7 | Submerged beds (coastal) |
| • Deep water: | | |
| Subtidal | 2 | Submerged beds (coastal) |
| ***Palustrine (freshwater):*** | | |
| • Vegetated: | | |
| Forested | 8 | Wooded swamp, bottom land hardwood, bog, pocosin (inland) |
| Scrub/shrub | 9 | Bog, pocosin (inland) |
| Emergent | 10 | Freshwater marsh, saline marsh, freshwater tidal marsh (inland) |
| Tundra[b] | — | Tundra |
| • Nonvegetated: | | |
| Unconsolidated shore | 11 | — |
| Open water | 12 | — |
| Other | 13 | — |
| ***Lacustrine (lakes):*** | | |
| • Deep water | 14 | — |

[a] Terminology for wetlands used in this chapter includes the classification used by NWTS (the recently adopted USFWS Classification System, with minor modifications to distinguish vegetated and nonvegetated types, and large or deepwater areas from small or shallow-water areas); the old USFWS Circular 39 Classification System; and lay language. Since strict correlations cannot be made between these three categories and information obtained by OTA, all three categories are used in this chapter. The use of this variety of terminology is intended to clarify, rather than confuse, the discussion.

[b] Tundra not included in NWTS data. Under the recent USFWS classification system it is a palustrine/moss-lichen wetland.

SOURCE: W. E. Frayer, T. J. Monahan, D. C. Bowden, and F. A. Grayhill, "Status and Trends of Wetlands and Deepwater Habitats in the Coterminous United States, 1950's to 1970's," Department of Forest and Wood Services, Colorado State University, Fort Collins, Colo., 1983, p. 31.

**Figure 6.—Changes in Wetlands Since the 1950's (thousands of acres)**



SOURCE: Original data from FWS's National Wetland Trends Study, 1982.

## Factors Affecting Wetland Loss

Major sources of loss identified in NWTS include conversions to agricultural use, urban use, deep water (lakes, subtidal areas), nonvegetated wetlands, and other uses (such as forestry, rangeland, and mining). Major development activities associated with these losses of wetlands included dredging and excavation, filling, draining and clearing, and flooding. These same activities were responsible for wetland losses in Alaska, although fill activities are probably the major source of Alaskan losses.

Wetland characteristics may change and acreages increase or decrease in response to natural factors apart from, or in addition to, the development activities listed above. For example, variations in climate have a major influence on the size and vegetation of wetlands in the prairie-pothole region and in Nebraska, as well as on the ease with which they can be altered for agricultural use (6,9). Natural succession and activity of increased beaver populations were the greatest factors associated with wetland *alteration* in Massachusetts between 1951 and 1977; however, development activities were responsible for far more actual *losses* of wetlands.

Also, changes in sea level, sedimentation, erosion, subsidence, and overgrazing by birds or mammals all have played a role in the loss of wetlands in coastal Louisiana (2). Because of the many factors involved, it is difficult to determine the significance of losses from natural processes relative to those from man's activities. However, there is evidence that until artificial hydrologic changes were made, such as containment of the Mississippi River and canal dredging, there was a slow, long-term net gain of land (including wetlands) in the region (2). The dramatic reverse of these gains implies that much of the loss is man-induced, resulting from a combination of sediment starvation; canal construction; saltwater intrusion from navigation channels; and freshwater pumping for rice irrigation, marsh impoundment, and cattle grazing (2). Losses reported by NWTS are discussed in more detail below, followed by a discussion of wetland trends reported in regional case studies.

The average annual net-loss rate for the Nation's vegetated wetlands in the lower 48 States during the 20-year period of NWTS was about 550,000 acres/yr, or about 0.5 percent of the Nation's wetlands each year. It must be recognized, however, that the rate of loss is not uniform throughout the country. For example, the Lower Mississippi Alluvial Plain lost nearly 190,000 acres/yr, or about 1.6 percent of the region's wetlands each year. The Pacific mountains lost 19,000 acres/yr, but this also represented about 1.6 percent of the region's wetlands lost each year. These two regions had loss

*Photo credit: OTA Staff, Joan Harn*

A combination of levee and canal construction, saltwater intrusion from navigation channels, freshwater pumping for rice irrigation, marsh impoundments, and cattle grazing have led to major wetland losses in coastal Louisiana rates that were three times the national average. The Atlantic and gulf coastal zones lost about 17,000 acres/yr, or about 0.35 percent of the combined regions' wetlands, a little more than half of the national rate.

Nonvegetated wetlands include about 6 million acres of estuarine and palustrine unconsolidated shore and other types of freshwater open water (areas less than 20 acres in size or less than 2 meters deep). Most of the net gain of about 2 million acres in these nonvegetated wetland types between the mid-1950's and mid-1970's involved the net increase of 1.7 million acres in freshwater, open water from the "other use" category (i.e., land that formerly was neither wetland, agricultural, or urban).

## *Trend Information*

Information from NWTS is the most reliable information available and is used here to identify major sources of loss. The data has strong statistical validity for *nationwide* figures on wetland gains and losses and represents what happened to wetlands prior to the implementation of the 404 program. Recent information on how these trends may have changed since the implementation of the 404 program in the mid-1970's and the initiation of other efforts to control wetland use is available on a qualitative basis only for some regions of the country. Regional information from NWTS and case studies provide less statistically precise trend information in specific areas of the country. The regional case studies also examine other information sources, including comparative studies and inventories, permit data, and personal interviews.

The recent availability of statistically reliable national estimates of wetlands in the mid-1950's and mid-1970's necessitates a reevaluation of previous estimates of the loss of "original" wetland acreage in the lower 48 States since the time of European settlement. All estimates of "original" acreage are limited by the lack of good data on the amount of land that has been drained or otherwise reclaimed and the relationship between wetlands and wetsoils. The following OTA analysis relies on a comparison of wetlands reported for the mid-1950's by NWTS (8) and the estimates of reclaimed lands for 1950 reported by Wooten (19). To develop an estimate of the maximum percentage of reclaimed lands that were wetlands, NWTS data were compared with the difference between improved lands reported by Wooten and agricultural lands on wetsoils in 1977 reported by the U.S. Department of Agriculture (USDA) (16).

The most commonly accepted estimate of 30- to 40-percent loss of original wetlands is based in part on estimates of wetland acreage both originally and in the 1950's reported in Circular 39 (3,15). In Circular 39, FWS estimated that a minimum of 45 million acres of wetlands had been reclaimed by the mid-1950's. If this estimate is valid and is added to the 104 million acres of wetlands that NWTS reported for the mid-1950's, then there would have been a minimum of 149 million acres of "original" wetlands, not the 127 million estimated by USDA's Soil Conservation Service (SCS). NWTS data, therefore, indicate that FWS Circular 39 estimates were about 20 percent too low.

The minimum value of 45 million acres of reclaimed wetlands by the mid-1950's was developed from data prepared by USDA; however, according to Wooten, a total of 135 million acres had been reclaimed by 1950. Many of these lands were probably just wetsoils, and not wetlands. The relationship between wetsoils and wetlands cannot be determined with existing information. Recent USDA information on wetsoils is correlated with Circular 39 wetland types 3-20 on non-Federal rural lands. NWTS information on wetlands uses the new FWS classification that doesn't correspond directly to Circular 39 wetland types 3-20, but instead to types 1-20. Also, NWTS doesn't distinguish Federal from non-Federal lands.

Sixty percent of the increase in agricultural land on wetsoils between the mid-1950's and mid-1970's appears to have come from wetlands if we compare the difference between improved lands reported by Wooten in the 1950's and agricultural lands on wetsoils in 1977 reported by USDA with NWTS estimates of wetlands in the mid-1950's and mid-1970's. This estimated 60 percent compares favorably with the estimate discussed later in this chapter, that 65 percent of the lands drained between 1955 and 1975 were wetlands. Assuming that the proportion of wetlands to wetsoils that are being converted to agricultural use probably has been increasing over time (since it's probably easier to convert wetsoils to other uses than wetlands), then the percentage of wetsoils that were reclaimed wetlands prior to the mid-1950's was 60 percent at most. If we then assume that at most 60 percent of the 135 million acres of reclaimed lands reported by Wooten were wetlands and add NWTS's estimate of 104 million acres of wetlands in the mid-1950's, we can derive a maximum value for "original" wetlands of 185 million acres.

Thus, previous estimates of loss of original wetlands probably were low. If the SCS estimate of 127 million acres of original wetlands is accepted, then losses may have been as low as 30 percent. If only one-third of the reclaimed lands were wetlands, as was assumed for the purposes of Circular 39, then there was an original acreage of 149 million acres for a loss of nearly 40 percent. If at most 60 percent of the reclaimed lands were wetlands (as a means of developing a maximum estimate of 185 million acres of original wetlands), then as much as 50 percent of the original wetlands may have been converted. All of these estimates are limited by the lack of good data on the amount of land that has been drained or otherwise reclaimed and the relationship between wetlands and wetsoils.

# VEGETATED WETLAND TRENDS

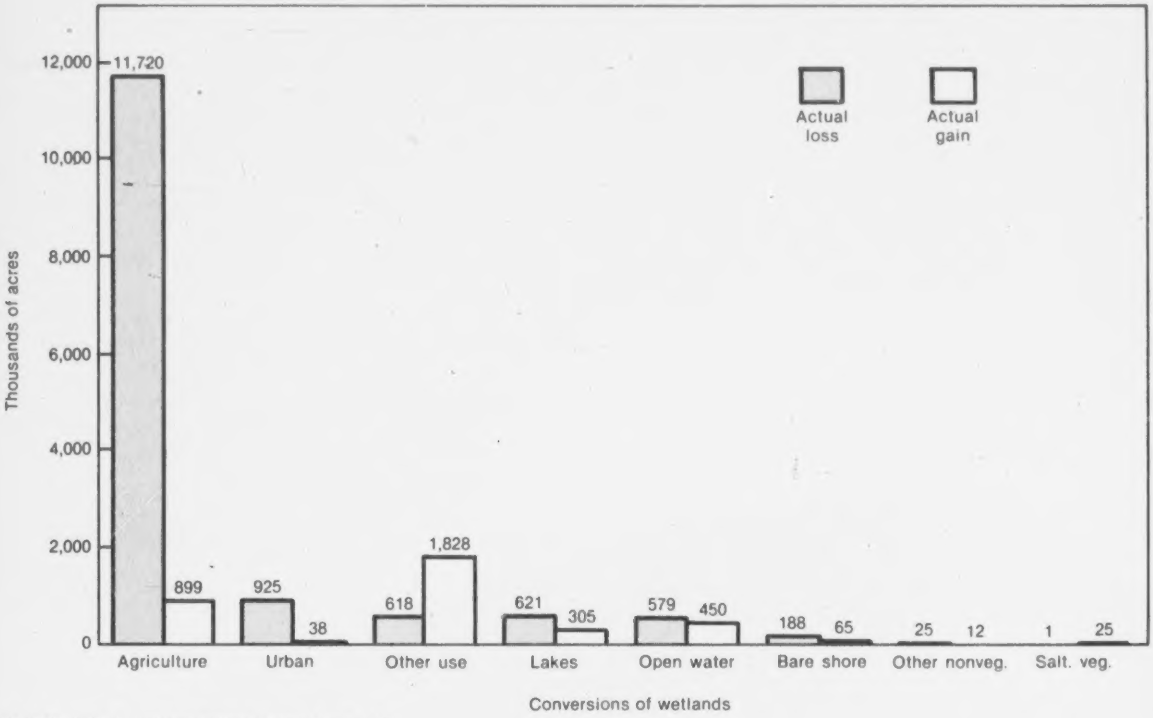
## *Freshwater Wetlands*

Since freshwater areas comprise 95 percent of the Nation's vegetated wetlands, freshwater wetland losses are similar to overall national trends (see fig. 7). There was a *net loss* of 11 million acres of freshwater vegetated wetlands between the mid-1950's and mid-1970's, representing a reduction of 11 percent. Forested wetlands accounted for 54 percent of the net loss of freshwater vegetated wetlands, emergent marshes accounted for 42 percent, and scrub-shrub wetlands accounted for 4 percent. Information on actual losses and gains are presented below and summarized in table 12.

*Actual losses* of freshwater vegetated wetlands totaled 14.6 million acres. Agricultural land use was responsible for 80 percent of these losses. The remaining 20 percent was comprised of urban use (6 percent), other use (4 percent), nonvegetated habitat (open water, 4 percent; unconsolidated shore, 1 percent; and other nonvegetated habitat, less than 1 percent), deepwater types (4 percent), and saltwater vegetated wetlands (less than 1 percent). These losses to nonvegetated open water and deep water are most likely associated with impoundments (e.g., farm ponds, water supply, flood control and recreational reservoirs, and waterfowl-management impoundments). They also could be associated with drainage practices that concentrate water in the lowest lying wetland to allow drainage of other wetlands in the watershed. Factors associated with the loss to unconsolidated shore might also be associated with impoundments, especially if water levels fluctuate. Other possible factors responsible for such loss include grazing, plowing, and natural climatic shifts associated with reductions in wetland vegetation. Losses to saltwater wetlands may result from decreased freshwater outflows or destruction of dikes in coastal areas.

*Actual gains* in freshwater vegetated wetlands totaled 3.6 million acres. Roughly 50 percent of the gains were from the "other uses" category. These gains can be accounted for primarily by increases in emergent and scrub-shrub wetlands surrounding newly constructed farm ponds on lands that were formerly neither wetlands nor in agricultural use. According to information from SCS, about 50,000 farm ponds, averaging 0.5 acre in size, were constructed each year during the period analyzed in NWTS (18). Other gains were from agriculture (25 percent), nonvegetated types (13 percent from open water and 2 percent from unconsolidated shore), deep water (8 percent), urban areas (1 percent), and saltwater vegetated wetlands (1 percent). Most of these gains probably were related to successional changes associated with abandonment of former land uses, such as the lack of maintenance of drainage ditches for forestry and agriculture, or natural factors like beaver activity, construction of roads that block drainage, construction of irrigation ditch

**Figure 7.—Freshwater Wetland Trends (mid-1950's to mid-1970's)**



SOURCE: USFWS National Wetland Trends Study, 1982.

**Table 12.—Probable Causes of Freshwater Vegetated Wetland Changes**

| | Acres | Cause of loss |
|---|---|---|
| ***Freshwater wetland loss to:*** | | |
| Agriculture | 11,720,000 | Drainage, flooding, excavation, clearing, land-leveling, filling, ground water pumping, and surface water diversions for conversion to cropland |
| Urban use | 925,000 | Fill for development |
| Deep water | 621,000 | Impoundments |
| Other use | 618,000 | Drainage, excavation, filling for forest management, mining, other |
| Open water | 579,000 | Impoundments, drainage/flooding, excavation, climatic changes |
| Unconsolidated shore | 188,000 | Impoundments, grazing, plowing, climatic changes |
| Other nonvegetated | 25,000 | — |
| Saltwater vegetated | 1,000 | Decreased freshwater outflow, destruction of dikes |
| Total | 14,677,000 | |
| | Acres | Cause of gain |
| ***Freshwater wetland gains from:*** | | |
| Other uses | 1,828,000 | Succession around margins of newly constructed farm ponds |
| Agricultural use | 899,000 | Lack of maintenance on drainage ditches, dikes |
| Open water | 450,000 | Succession around margins of existing ponds |
| Deep water | 305,000 | Succession around margins of larger water bodies |
| Unconsolidated shore | 65,000 | Vegetation establishment |
| Urban use | 38,000 | Drainage and open space management |
| Saltwater vegetated wetlands | 25,000 | Increased freshwater outflow, construction of dikes |
| Other nonvegetated | 12,000 | — |
| Total | 3,622,000 | |

SOURCE: Data from FWS National Wetland Trends Study, 1983.

systems that may leak and support some wetland vegetation, and construction of dikes in coastal areas.

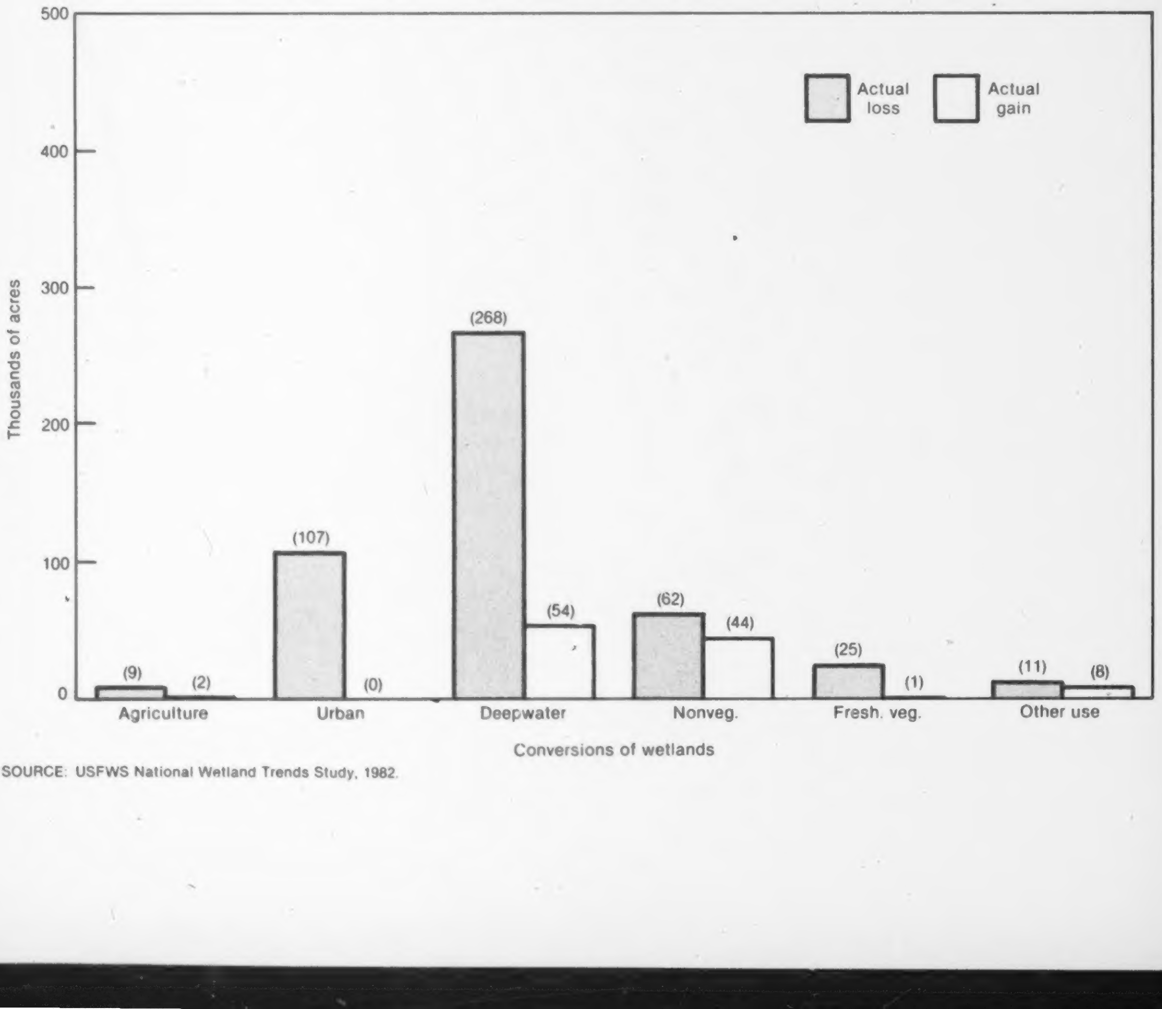
## Saltwater Wetlands

Saltwater-loss trends differ from those of freshwater since conversions to deep water and urban use are most prevalent. Agricultural use has had little impact on saltwater wetlands in recent years (see fig. 8). There was a *net loss* of 373,000 acres of saltwater vegetated wetlands between the mid-1950's and mid-1970's, representing a 7.6-percent reduction. Emergent saltwater wetlands comprised 95 percent of these net losses. The remaining 5 percent were saltwater forested and scrub-shrub wetlands. Information on actual losses and gains is presented below and summarized in table 13.

*Actual losses* in saltwater vegetated wetlands totaled 482,000 acres. Conversions to deep water were responsible for 55 percent of these losses. This amount probably can be attributed to dredging for canals, port and marina development, and erosion. Urban use accounted for 22 percent of the losses. Conversions to nonvegetated types (i.e., unconsolidated shore, 11 percent; and other, 2 percent) were likely to be associated with dredged-material disposal practices, removal of vegetation for recreational development, such as beach creation, and death of vegetation associated with changes in salinity. Transitions to freshwater vegetated wetlands were responsible for 6 percent of the losses. Such transitions could be related to increases in freshwater outflow or dike construction. Agriculture and other uses were each responsible for 2 percent of the losses.

*Actual gains* in saltwater vegetated wetlands totaled 109,000 acres. Roughly 50 percent of the gain was from deepwater areas, and 40 percent was

**Figure 8.—Saltwater Wetland Trends** (mid-1950's to mid-1970's)



SOURCE: USFWS National Wetland Trends Study, 1982.

Table 13.—Probable Causes of Saltwater Vegetated Wetland Changes

| | Acres | Cause of loss |
|---|---|---|
| ***Saltwater wetland loss to:*** | | |
| Deep water | 268,000 | Dredging for canals, port and marina development, erosion |
| Urban use | 107,000 | Fill for development |
| Unconsolidated shore | 50,000 | Dredged material disposal, removal of vegetation for recreational development, death of vegetation |
| Freshwater vegetated wetlands | 25,000 | Increased freshwater outflow, dike construction |
| Agriculture | 9,000 | Diking for conversion |
| Other uses | 11,000 | Filling for port development |
| Other nonvegetated | 12,000 | — |
| Total | 482,000 | |
| | Acres | Cause of gain |
| ***Saltwater wetland gain from:*** | | |
| Deep water | 54,000 | Natural establishment of vegetation, marsh creation efforts |
| Nonvegetated types | 44,000 | Same as deep water |
| Other uses | 8,000 | Same as deep water |
| Agriculture | 2,000 | Destruction of dikes |
| Freshwater vegetated wetlands | 1,000 | Reductions in freshwater outflow, dike construction, increased saltwater inflow |
| Total | 109,000 | |

SOURCE: Data from FWS National Wetland Trends Study, 1983.

from nonvegetated types. Reasons for these changes probably include natural establishment of vegetation and marsh-creation efforts associated with dredged-material disposal and erosion-control practices. Other uses were responsible for 7 percent of these gains, and abandonment of agricultural lands accounted for 2 percent of the gains. The remaining 1 percent were gains from freshwater vegetated wetlands that may be associated with reductions in freshwater outflow, destruction of dikes, or increased saltwater flow.

## *Regional Trends*

Using national figures of wetland losses and gains can be misleading. Farm ponds—such as in Missouri—even with aquatic plant improvements through plant succession, cannot compensate for potholes lost in the prairie-pothole area. A wide variety of migratory birds uses the latter for reproduction and rarely or infrequently uses the former. Regional information on wetland use was obtained by OTA from four primary sources: NWTS, other inventory and trend studies, permit information, and interviews.

### NWTS (8)

For OTA's study, NWTS grouped its data into 13 regions so that wetland losses and gains on regional levels could be analyzed. The regions are listed in table 14 and shown in figure 9. Although this study was based on a stratified random sampling, very large standard errors are associated with its data on a regional level.[1] The regional data reflect actual losses and gains in wetlands and other land uses at the sample sites. Such data indicate probable trends in wetland use in a region, especially if they can be supported by other sources of evidence.

Regional data provide an average picture over a large area and do not necessarily reflect the actual status of wetlands within a single State in the region. For example, in the Upper Midwest, Illinois lost 186,905 acres, or 23 percent, of the wetlands that were present in the mid-1950's; Wisconsin lost 133,872 acres, or 3 percent, of wetlands present in

---

[1] The following explanation of statistical reliability is from W. E. Frayer & Associates, "Status and Trends of Wetlands and Deepwater Habitats in the Coterminous United States, 1950's to 1970's—Final Draft 1982," National Wetlands Inventory, Office of Biological Services, U.S. Fish and Wildlife Service:

> Standard errors for overall wetland loss figure for physiographic regions range from a low of 11 percent of the measured loss in the gulf coastal zone to a high of over 134 percent of the measured loss in the intermontane region. The majority of the standard errors for physiographic regions are from 15 to 35 percent of the measured loss. Reliability can be stated generally as "we are 68 percent confident that the true value is within the interval constructed by adding to and subtracting from the entry the SE%/100 times the entry." For example, if an entry is 1 million acres and the SE percent is 20, then we are 68-percent confident that the true value is between 800,000 and 1.2 million acres. An equivalent statement for 95-percent confidence can be made by adding and subtracting twice the SE%/100 to and from the entry, respectively.

**Table 14.—Physiographic Regions Used for Regional Analysis of National Wetland Trends Study Data**

| Region |
|---|
| 1—Atlantic coastal zone[a] |
| 2—Gulf coastal zone[b] |
| 3—Atlantic coastal flats[a] |
| 4—Gulf coastal flats[b] |
| 5—Gulf-Atlantic rolling plain |
| 6—Lower Mississippi Alluvial Plain |
| 7—Eastern highlands |
| 8—Dakota-Minnesota drift and lake bed flats |
| 9—Upper Midwest |
| 10—Central |
| 11—Rocky Mountains |
| 12—Intermontane |
| 13—Pacific mountains |

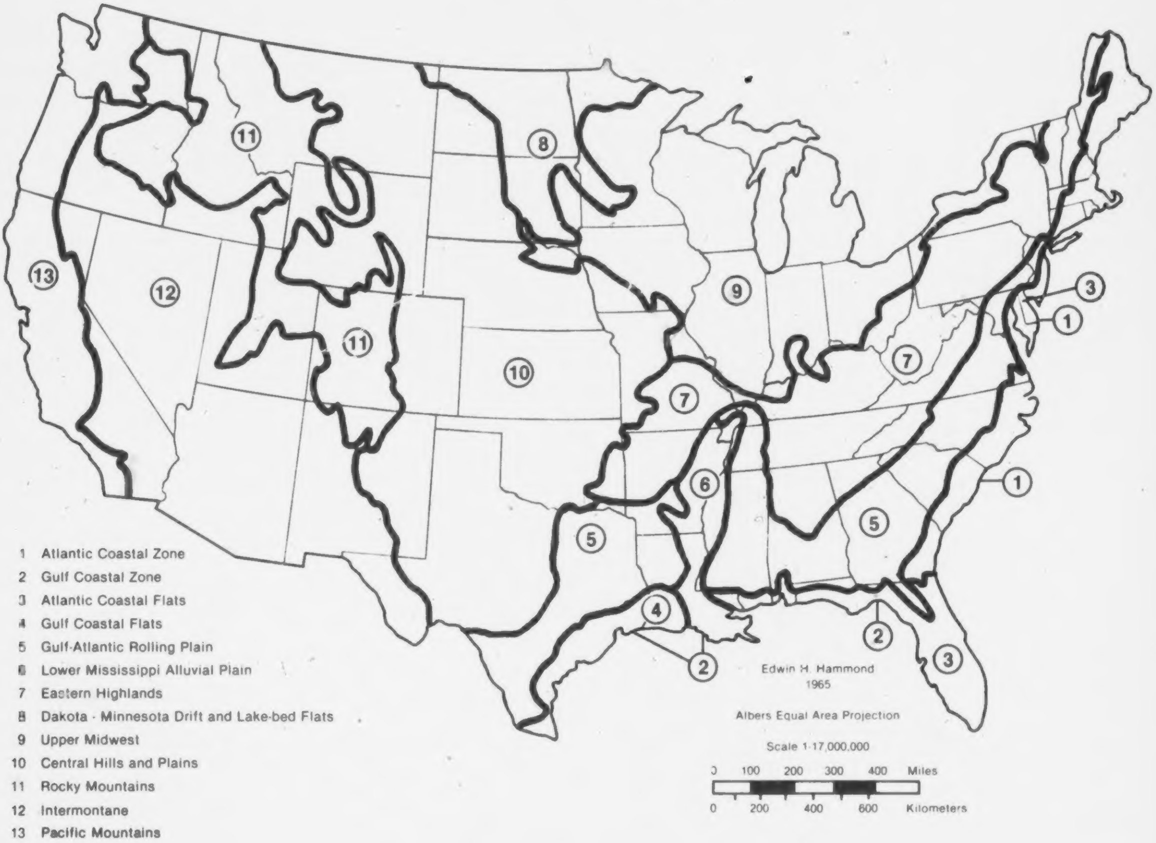
[a] Atlantic regions do not include Florida.
[b] Gulf regions include Florida.

SOURCE: Office of Technology Assessment.

the region. Data from Minnesota more closely reflect the trends for the entire region. Minnesota lost 447,709 acres, or 8 percent, of wetlands in the upper midwest portion of the State.

The proportion of wetlands and percentage of loss vary considerably in the different physiographic regions (see table 15). Three regions have a greater proportion of land area as wetlands and a greater loss rate than the national averages of 5 percent and 11 percent, respectively: Lower Mississippi Alluvial Plain, gulf coastal flats, and gulf-Atlantic rolling plain. Five regions have a greater proportion of land area as wetlands and loss rates at less than or equal to the national averages: Atlantic coastal zone, gulf coastal zone, Atlantic coastal flats, Dakota-Minnesota drift and lakebed flats, and Up-

**Figure 9.—Physical Subdivisions**


1 Atlantic Coastal Zone
2 Gulf Coastal Zone
3 Atlantic Coastal Flats
4 Gulf Coastal Flats
5 Gulf-Atlantic Rolling Plain
6 Lower Mississippi Alluvial Plain
7 Eastern Highlands
8 Dakota - Minnesota Drift and Lake-bed Flats
9 Upper Midwest
10 Central Hills and Plains
11 Rocky Mountains
12 Intermontane
13 Pacific Mountains
Edwin H. Hammond
1965
Albers Equal Area Projection
Scale 1:17,000,000
0 100 200 300 400 Miles
0 200 400 600 Kilometers

### Table 15.—Pattern of Wetland Loss by Physiographic Region

| Region | Wetland portion of region (mid-1950's) (%) | New loss of wetlands (mid-1950's-mid-1970's (%) | Actual loss (acres) | Actual gain (acres) | Standard error for net change (%) |
|---|---|---|---|---|---|
| 1—Atlantic coastal zone[a] | 16 | 3 | 84,000 | 48,000 | 52.3[c] |
| 2—Gulf coastal zone[b] | 28 | 9 | 371,000 | 70,000 | 11.3[d] |
| 3—Atlantic coastal flats[a] | 36 | 11 | 1,274,000 | 74,000 | 15.0[e] |
| 4—Gulf coastal flats[b] | 27 | 13 | 1,872,000 | 341,000 | 14.5[f] |
| 5—Gulf-Atlantic rolling plain | 8 | 13 | 2,310,000 | 291,000 | 31.2[g] |
| 6—Lower Mississippi Alluvial Plain | 36 | 32 | 3,749,000 | 331,000 | 8.6[h] |
| 7—Eastern highlands | 2 | 2 | 322,000 | 211,000 | 68.8[g] |
| 8—Dakota-Minnesota drift and lake bed flats | 10 | 9 | 816,000 | 424,000 | 33.6[g] |
| 9—Upper Midwest | 8 | 7 | 2,286,000 | 754,000 | 16.8[g] |
| 10—Central | 1 | 3 | 763,000 | 637,000 | (i) |
| 11—Rocky Mountains | 4 | <1 | 125,000 | 112,000 | (i) |
| 12—Intermontane | 1 | 12 | 685,000 | 320,000 | (i) |
| 13—Pacific mountains | 1 | 31 | 473,000 | 94,000 | 77.1 |

[a] Atlantic regions do not include Florida.
[b] Gulf regions include Florida.
[c] Standard error given is for saltwater wetlands. The freshwater wetlands had a net gain of 10,626 acres with a standard error of 86.9 percent.
[d] Standard error given is for saltwater wetlands. The freshwater wetlands had a net gain of 2,137 acres with a standard deviation greater than this value.
[e] Standard error given is for freshwater wetlands. Saltwater wetlands had a net loss of 866 acres with a standard deviation greater than this value.
[f] Standard error given is for freshwater wetlands. Saltwater wetlands had a net gain of 933 acres with a standard error of 81.6 percent.
[g] Standard error is for all vegetated wetlands measured in region which included exclusively freshwater types.
[h] Standard error is for freshwater wetlands. Saltwater wetlands had a net loss of 22,282 acres with a standard error of 67.8 percent.
[i] Standard deviation is greater than estimated net change.

SOURCE: Original data from FWS National Wetland Trends Study, 1983.

per Midwest. Two regions have a lower proportion of land area as wetlands and loss rates greater than the national average: Pacific mountains and Intermontane. Three regions have a lower proportion of land area as wetlands and loss rates less than the national average: Eastern highlands, Central, and Rocky Mountains. Although the amount of wetland acreage lost from these areas with relatively few wetlands may not have contributed much to the national totals, such losses may be environmentally significant on a regional level.

The percentage of wetland loss to various activities varies among the physiographic regions (see table 16). The actual losses of vegetated freshwater wetlands to agriculture range from 1 to 90 percent. However, agricultural use was the greatest cause of loss of vegetated freshwater wetlands in all regions, and the proportion of agricultural loss was greater than the national average (i.e., 80 percent) in six regions.

In all 11 physiographic regions with predominantly vegetated freshwater wetlands, the losses to agriculture were greater than any gains in wetlands from agriculture. However, there were two exceptions to this net loss to agriculture when data from *subdivisions* comprising the physiographic regions were examined. (Standard errors are extremely high for subdivision data.) Agriculture is a source of net gain of wetlands in the Adirondack-New England subdivision of the Eastern highlands region. This trend is supported by the findings of the New England case study, which notes increases in wetlands from agricultural abandonment and the lack of maintenance of drainage ditches. Agriculture is also a source of net gain of wetlands in the Columbia Basin subdivision of the Intermontane region. Wetland increases associated with irrigation development may be partially responsible for this trend.

Conversions to urban use were the second most important cause of actual losses in two regions, the third most important cause in three regions, and the least important cause in six regions. Proportions of loss to urban use range from 0 to 36 percent. These proportions are greater than the national average (6 percent) for urban loss in three regions: gulf coastal flats, Eastern highlands, and Upper Midwest.

In all regions, losses to urban use were greater than any gains in wetlands from this use, with one

**Table 16.—Percentage of Vegetated Wetland Loss to Different Uses by Physiographic Region[a] (mid-1950's to mid-1970's)**

| Region | Agriculture | Urban | Other | Water/nonvegetated |
|---|---|---|---|---|
| 1—Atlantic coastal zone[b] | 5 | 36 | 5 | 54 |
| 2—Gulf coastal zone[c] | 1 | 19 | 2 | 78 |
| 3—Atlantic coastal flats[b] | 89 | 6 | 2 (+) | 3 |
| 4—Gulf coastal flats[c] | 66 | 19 | 4 (+) | 11 |
| 5—Gulf-Atlantic rolling plain | 84 | 3 | 4 (+) | 9 |
| 6—Lower Mississippi Alluvial Plain | 90 | 3 | 3 (+) | 4 |
| 7—Eastern highlands | 38 | 22 | 5 (+) | 35 |
| 8—Dakota-Minnesota drift and lake bed flats | 83 | 1 | 4 (+) | 12 (+) |
| 9—Upper Midwest | 71 | 8 | 3 (+) | 18 |
| 10—Central | 63 | 5 | 15 (+) | 17 (+) |
| 11—Rocky Mountains | 71 | 0 | 19 (+) | 10 (+) |
| 12—Intermontane | 88 | 1 | 7 (+) | 4 (+) |
| 13—Pacific mountains | 87 | 1 | 7 (+) | 5 |

[a] (+) indicates there was a net gain in wetlands from the use category in the region. If (+) is not indicated, then there was a net loss from that use category.
[b] Atlantic regions do not include Florida.
[c] Gulf regions include Florida.

SOURCE: Original data from FWS National Wetland Trends Study, 1983.

exception. Urban use is a source of wetland gain in the West central rolling hills subdivision of the Central region which can be attributed to a gain in wetlands in Iowa, accompanied by a slightly lower rate of wetland conversion to urban use in Nebraska. Gains of wetlands from urban use in Iowa could be associated with flood plain management activities.

The combined category of deep water, open water, and other nonvegetated types was the second most important cause of actual losses of vegetated freshwater wetlands in six of the regions and the third most important cause in the remaining five regions. The proportion of these losses was greater than the national average (10 percent) in five regions.

These losses to deep water, open water, and other nonvegetated types were accompanied by gains in freshwater vegetated wetlands from these categories, resulting in a net gain in 4 of the 11 regions, including Dakota-Minnesota drift and lakebed flats, Central, Rocky Mountains, and Intermontane. All other regions had a net loss of vegetated wetlands from these categories. Subdivision data on these net changes show five exceptions each for the general region trends of net loss and net gain of vegetated wetlands from this category. Again, standard errors for these numbers are very high.

Conversions to other uses were the second most important cause of loss in three regions, the third in four regions, and last in the remaining four regions. Proportions of loss from other uses range from 2 to 19 percent. These proportions are greater than the national average (4 percent) in five regions. In all regions, these losses to other uses were accompanied by gains, resulting in a net gain in freshwater vegetated wetlands from this category. This gain is relatively small when compared to the overall losses of wetlands.

Two physiographic regions comprise 98 percent of the data for saltwater wetlands: Atlantic coastal zone and the gulf coastal zone. The remaining 2 percent is primarily from the Lower Mississippi Alluvial Plain. A very small amount of saltwater wetlands was also measured in the gulf and Atlantic coastal flats regions. No data were collected for saltwater wetlands of the Pacific coast.

The Atlantic coastal zone and gulf coastal zone (including Florida) both showed a net loss of salt and brackish wetlands. However, in the Atlantic region, this loss was attributed primarily to urban use. There was also a net loss due to agriculture, conversions to freshwater wetlands, and other uses. A net gain of vegetated wetlands resulted from deep water, open water, and other unvegetated areas. In the gulf region, the net loss of salt and brackish wetlands was due primarily to deep water and nonvegetated areas. Louisiana and Florida accounted for 84 percent and 10 percent of these losses, respectively. Erosion, subsidence, and dredging for canals and marinas were probably responsible for these trends. Urban losses also were significant. Additional losses were due to agricultural and other uses.

## Regional Case Studies

Ten OTA regional case studies (table 17) of trends in wetland use in 21 States provided information from three major sources:

- Wetland inventory and trend information (other than NWTS): There are few reliable trend studies. Moreover, there are many problems with comparing inventory studies to establish trends, owing to variations in wetland definitions, size categories, and study areas. For example, in Minnesota, a 1950 inventory examined wetlands within 15,803 square miles (mi$^2$) of the prairie-pothole region. A 1955 inventory looked at Circular 39 types 1-8 in western Minnesota; in 1964, types 3-5 were inventoried in 19 western Minnesota counties; and in 1982, types 3-5 (over 10 acres) were inventoried in 14 western Minnesota counties (6).
- Permit information on section 404 and State programs: There are few cases where data have been compiled for particular permit programs. Data that are available generally report only what has been allowed under the reported permit program and exclude information on illegal activity and activities taking place in wetlands that aren't covered by the permit pro-

Table 17.—Wetland Case Study Sites

| Region/States | OTA contractor |
|---|---|
| New England/Massachusetts, Connecticut, Rhode Island, Vermont, Maine, and New Hampshire | Water Resources Research Center<br>University of Massachusetts<br>Amherst, Mass. 01003 |
| North and South Carolina | School of Forestry and Environmental Studies<br>Duke University<br>Durham, N.C. 27706 |
| Gulf Coast and Lower Mississippi River/Louisiana, Texas, and Mississippi | Coastal Ecology Laboratory<br>Center for Wetland Resources<br>Louisiana State University<br>Baton Rouge, La. 70803 |
| Prairie Potholes/Minnesota, North and South Dakota | Department of Agricultural Economics and Center for Environmental Studies<br>N.D. Agricultural Experiment Station<br>North Dakota State University<br>Fargo, N.D. 58105 |
| California and Alaska | ESA/Madrone, Environmental Consultants<br>23-B Pamaron Way<br>Novato, Calif. 94947 |
| New Jersey | JACA Corporation<br>550 Pinetown Road<br>Fort Washington, Pa. 19034 |
| Washington | Shapiro and Associates, Inc.<br>The Smith Tower, Suite 812<br>506 Second Avenue<br>Seattle, Wash. 98104 |
| Nebraska | Center for Great Plains Studies<br>1213 Oldfather Hall<br>Lincoln, Nebr. 68588 |
| Florida | Center for Governmental Responsibility<br>Holland Law Center<br>University of Florida<br>Gainesville, Fla. 32611 |

SOURCE: Office of Technology Assessment.

gram. The 404 program provides only very general unverifiable estimates of acreages of wetlands converted by permitted projects on a districtwide basis.

- Interviews: Interviews are probably the best qualitative source of information if they are accompanied by information from the other data sources. However, they must be viewed strictly as expert testimony.

OTA information from the regional case studies allows the following general conclusions about past and current wetland trends:

- Agricultural practices are a major factor associated with wetland loss in inland areas of North Carolina, South Carolina, Maryland, Florida, Nebraska, and California, plus the prairie-potholes and Lower Mississippi River Valley. Losses to wetlands continue in these areas today. More detailed information on agricultural conversions is provided at the end of this chapter.
- Loss of coastal freshwater and saltwater wetlands to open water, deep water, and unvegetated areas through dredging and filling for marinas and canals is a major factor in South Carolina, North Carolina, Texas, Louisiana, California, New Jersey, Florida, and Washington. The rate of loss from man's activities has been reduced as a result of regulatory efforts under the Federal section 404 program and State programs. Some projects are not approved; others are approved with required measures for restoration or creation of wetlands. Regardless of mitigation measures, however, losses continue to occur.
- Loss of inland wetlands to open and deep water areas from impoundments occurs in New England, Nebraska, Lower Mississippi River Valley, and prairie-potholes areas. Losses related to agricultural development and the farm pond exemption continue, although the construction of farm ponds may result in new wetlands forming on adjacent lands. Losses from newly designed impoundments and channels for flood control and municipal water supply continue, but projects are handled in a more environmentally sensitive manner in accordance with Federal and State environmental and regulatory policies. Some projects may require mitigation.
- Urban development has been a major factor in wetland loss in coastal areas in South Carolina, Florida, Mississippi, California, Washington, New Jersey, New England, and Alaska. Federal and State regulatory programs have slowed the loss considerably. Current losses usually are restricted to water-dependent projects and often require mitigation. Losses continue in areas that are not subject to regulation and from small projects that potentially may have significant cumulative impacts. Losses also continue in areas (e.g., southeast and south-central Alaska) where there are few alternative construction sites in nonwetlands.
- Sources of loss from other uses include forestry, mining, port development, road construction, and succession to nonwetlands. These activities are important to varying degrees in many areas, including North Carolina, the Lower Mississippi River Valley, Florida, New England, Nebraska, prairie-potholes, Maryland, California, Alaska, and Washington. Losses continue for nonregulated activities and areas. Losses also continue for activities subject to regulation, but again are generally handled in a more environmentally sensitive manner in accordance with Federal and State environmental and regulatory policies.

Case study information can reveal further some of the specific factors associated with these losses in different regions. The following tables summarize case study information on the major national trends for vegetated wetlands. Tables 18 to 21 present information on conversions to agriculture, open and deep water, urban development, and other uses, respectively. Conversions to other nonvegetated wetlands were not addressed specifically in the case studies. The category "other uses" includes information on forestry, mining, ports, road construction, and activities in nonwetlands. The tables include information on how the conversions are accomplished, important regions and types of wetland involved, reasons why the changes occur, and current and past trends, where available. Impacts of activities causing conversions are discussed further in chapter 6; the current programs that reg-

## Table 18.—Agricultural Conversions of Wetlands (mid-1950's to mid-1970's)

| How accomplished | Important regions/ wetland types | Reasons | Trend |
|---|---|---|---|
| Major drainage, flooding | Prairie potholes of Minnesota, North Dakota, South Dakota/shallow, moderately deep marshes and seasonally flooded flats | Opportunity to gain additional cropland<br>Elimination of nuisance by avoiding potholes within cropland.<br>Change in farming from diversified crops and livestock to row crops and small grain<br>Increase in tractor horsepower<br>Increases avoidance costs<br>Increase in center-pivot irrigation<br>Climatic variations<br>Absence of financial incentives to maintain wetlands<br>Drainage opportunities from channel projects and rural roads ditches<br>Tax benefits for drainage | Of original, 25 to 30 percent of acres remain; greatest percentage and acreage drained in Minnesota. However, this is extremely variable within region, varying by 12 to 95 percent. Continuing conversion. Annual drainage rates estimates range from 0.1 to 5.0 percent. Almost half remaining wetlands are under protective programs; of these, 90 percent are permanent forms |
| Major drainage, flooding, excavation, land-leveling | Nebraska Rainwater Basin/shallow, moderately deep marshes and seasonally flooded flats | Intensify or expand cropland<br>Drainage opportunities through rural road upgrading and improvement<br>Drought incidence<br>Possible Federal or State cost-sharing assistance for reuse systems or leveling associated with irrigation<br>Tax benefits for drainage<br>Available farm equipment | Continuing conversion. Remaining are 15- to 25-percent original acres and 10- to 15-percent original basins. Protection programs cover 50 to 85 percent of remaining acreage. Nearly 90 percent of these are in permanent form |
| Ground water pumping, associated land-leveling and filling | Nebraska Sandhills/wet meadows | Conversion of rangeland to cropland<br>Long-term reduction in ground water levels and seasonal ground water variations due to expanding center-pivot irrigation<br>Increase efficiency of center pivot<br>Expand hay production into wetter areas | Accelerating conversion rate in last 10 years. Remaining are 85 to 95 percent of original acres and more than 95 percent of original basins |
| Ground water pumping, surface water diversions | Nebraska—Central Platte Valley/wet meadows | Indirect impact of regional irrigation development<br>Conversion of rangeland to cropland | Of original wet meadows 30 to 45 percent remaining |
|  | California—Klamath Basin/emergent marshes | Conversion of rangeland to cropland | Of original acreage 40 percent remaining. Continuing conversions on private and managed wetlands. Approximately 50 percent of remaining wetland and lake areas in national wildlife refuges and State wildlife management areas |
| Normal farming: land-leveling of flood-irrigated areas, shift in crops, shift in planting and harvest schedules | California—Central Valley/emergent marshes | Less water available<br>Increased pumping costs<br>Clean farming practices<br>Pesticide/herbicide use<br>Flood control<br>Irrigation technology | More than 90 percent converted from 1850 to 1978. Continuing conversions of ricelands to less water-intensive crops. Degradation of habitat on secondary wetland areas. Of remaining acreage, 20 percent in public ownership |
| Drainage, land-leveling | California—Central Valley/emergent marshes | Less water available<br>Higher taxes on nonagricultural lands<br>Increased pumping costs<br>Degradation of habitat on secondary wetland areas | See above description of overall trends of Central Valley. Conversion of private wetlands to agriculture. Reduction of flooded public acreage |

## Table 18.—Agricultural Conversions of Wetlands (Continued)

| How accomplished | Important regions/ wetland types | Reasons | Trend |
|---|---|---|---|
| Clearing vegetation | Lower Mississippi River Valley/bottom land hardwoods | Soybean demand<br>Relative price of timber<br>Drought incidence<br>Flood-control projects | Significant conversion prior to 1937. Forty-four-percent reduction, 1937 to 1977. Forest remaining 0 to more than 60 percent (1979). Rate of clearing peaked 1967 (except Louisiana). Clearing rates related to remaining forest. Continuing conversion |
| Clearing vegetation drainage | North and South Carolina/bottom land hardwoods | Relative price of timber<br>Improved drainage equipment<br>Refined use of lime, fertilizer, pesticides<br>Improved seed stocks<br>Agribusiness investment | Increase from 1930's to 1950's from reforestation of abandoned farms. Increasing rate of conversion 1950's to 1970's |
| Clearing vegetation, drainage | North Carolina/pocosins | Improved drainage equipment | By 1979, 33 percent totally developed. Of remaining areas, 65 percent owned by agricultural and forest products industries. Five percent protected from drainage through public ownership or lease |
| Clearing vegetation, drainage | South Carolina/carolina bays | Large-scale agriculture<br>Forestry | Ninety-five percent altered |
| Clearing vegetation, drainage | South Florida/cypress | Agricultural and urban uses | Conversions occurred from 1900 to 1973, including 25 percent of cypress domes and stands and 12 percent of scrub cypress. Continuing conversions |
| Lack of drainage, ditch maintenance | New England/wooded wetlands | Agricultural abandonment | Wetlands recreated |
| Mowing, seeding, fertilizing, grazing | South Florida/wet prairies, sawgrass | Expanded agriculture<br>Transform areas to dry land to prepare for urban development (and avoid regulations associated with fill in wetlands) | Conversion of 45 to 52 percent of wetlands from 1900 to 1973. Continuing conversions |

SOURCE: OTA Regional Case Studies.

## Table 19.—Conversions of Wetlands to Open-Water and Deep-Water Environments

| How accomplished | Region/type | Reasons | Trend |
|---|---|---|---|
| Fill, flooding | New England/forested and marsh | Municipal reservoirs<br>Flood control<br>Blocked drainage from highway construction<br>Farm ponds<br>Recreational ponds<br>Beaver activity | Majority of change from beaver activity. Between early 1950's to mid-1970's 47 percent of change from man's activities attributed to impoundments. Continuing conversions but with reduced impacts on wetlands from large-scale project due to regulatory requirements. Continuing conversions to farm ponds |
| Fill, flooding, excavation | Lower Mississippi River Valley/forested and marsh | Flood control impoundments, navigation channels | Continuing construction of formerly authorized projects (e.g., Yazoo Pumps) |
| Fill, diversion, flooding, excavation | Lower Colorado River Valley, Salton Sea/desert riparian marshes and forests | Flood control, irrigation, urban water-supply impoundments | Most of conversions associated with dams building occurred prior to 1940's. Channelization, dredging, and levee projects continue. Some wetlands created in large impoundments. Small habitat restoration and preservation activities along river |
| Flooding | Prairie potholes—Minnesota, North Dakota, South Dakota/emergent marsh | Concentrate surface water and provide drainage for other wetlands | See trends for agricultural conversions—table 18. |
| Flooding, excavation | Nebraska Rainwater Basin/marsh | Create irrigation reuse pits<br>Reservoirs<br>Irrigation canals | See trends for agricultural conversions—table 18 |
| Fill, flooding, diversions | Nebraska—Platte River Valley, other rivers and streams/marsh and riparian habitat | Impoundments and diversions for irrigation and power | See agricultural conversions—table 18 |
| Fill, flooding | South Carolina coast/fresh and salt marsh | Impoundments for rice culture, waterfowl management | Transition from swamp and salt marsh to fresh marsh. Impoundment construction in 19th century. Majority now managed for waterfowl. Areas not maintained reverted to original state. Resurgence of interest in reconstructing old impoundments mostly for wintering waterfowl and hunting. Some interest in aquaculture. Proposed impoundments in these areas covered the majority of permit applications for South Carolina. Very little was permitted in 1978 |
| Fill, flooding, excavation | North Carolina coast/salt marsh | Impoundments and ditches for mosquito control | From 1956 to 1967, 17 percent of salt marsh converted. Rate of conversion slowed by using pesticides, open marsh water-management. Difficulty in getting 404 permits because of questions about success of control techniques and magnitude of problem |
| Dredging, fill, erosion, subsidence, salinity intrusion | Mississippi deltaic plain—coastal Louisiana and Mississippi/fresh and salt marsh | Natural processes:<br>—storm-caused erosion<br>—subsidence<br>—sea-level rise<br>Development activities:<br>—canals for oilfield access (spoil banks)<br>—harbors<br>Combination natural/development:<br>—prevent sediment from accumulating and compensating for natural losses<br>—salinity intrusion from canals kills freshwater vegetation<br>—some impoundments | From 1955 to 1978, 55 percent of fresh marsh converted to other uses. Continuing conversions. Slight increase in salt marsh (2 percent), 1955 to 1978. Net loss of all marsh, approximately 20 percent. Canals responsible for 65 percent or more of total conversion |

### Table 19.—Conversions of Wetlands to Open-Water and Deep-Water Environments (Continued)

| How accomplished | Region/type | Reasons | Trend |
|---|---|---|---|
| Dredging, fill, erosion, subsidence, salinity intrusion | Chenier Plain—Texas, southwest Louisiana/fresh and salt marsh | Direct wetland conversions due to dredging<br>Additional conversions induced by canals for oil access<br>Some impoundments, ricefields | From 1952 to 1974, 30 percent of marsh (fresh and salt) converted to other uses. Continuing conversions |
| Fill, flooding, clearing | Coastal Louisiana/fresh and salt marsh and swamp | Crayfish culture—construction of leveed open ponds, use of ricefields, clearing swamp and marsh ponds | Thirtyfold increases in acreage for crayfish culture from 1960 to 1980. Uncertain whether clearing of forested wetlands will increase because of questions about relative productivity of open v. forested ponds. Uncertain how State regulatory program will deal with requests to clear lands. Of current crayfish culture, 45 percent of area is swamp/marsh ponds; the remainder are ricelands and open ponds |
| Dredge and fill | South Carolina coast/barrier islands—fresh and salt marsh | Water-dependent development<br>Marinas, ports (restrictions on certain marina development activities) | Probably a reduced rate of conversion and now only for water-dependent activities. Less than 100 acres of saltwater wetlands converted since 1977. About 3,000 fresh and saltwater acres converted between 1954 and 1968 |
| Dredge and fill | New Jersey coast/fresh and salt marsh | Residential lagoons<br>Marinas | Tens of thousands of acres converted during 1950's and 1960's. Conversions considerably reduced since 1973. Compensation of wetlands required for large controversial projects. Few acres initially converted in Atlantic City region |
| Dredge and fill | Florida/barrier islands—mangroves | Finger-fill canals | Reduced conversion rates due to regulation |
| Dredge and fill | Southern California coast | Marinas | Reduced conversion rates due to regulation |
| Flooding | Alaska—southcentral and southeast regions/flood plain wetlands | Hydroelectric development | Increased demands for power; several hydroprojects currently being planned |

SOURCE: OTA Regional Case Studies

## Table 20.—Wetland Losses From Urban Development

| How accomplished | Region/type | Reasons | Trend |
|---|---|---|---|
| Fill, stormwater management | South Carolina—Hilton Head Island/freshwater marshes | Barrier island development—resorts and second homes | Prior to implementation of Special Area Management Plan in 1982, 33-percent conversion and 20-percent alteration of freshwater wetlands. Plan should help reduce these changes |
| Fill | New Jersey—pinelands/forested wetlands | Residential, commercial development | Conversion of several thousand acres per year in 1960's and 1970's. Since 1979, rates of conversion have declined to perhaps several hundred acres per year as a result of Pinelands Commission policies. Protection of Atlantic white cedar |
| Fill | New Jersey—Passaic Basin/freshwater meadows and swamps | Highway development; subsequent residential, industrial, and commercial use | Reduction by 20 to 50 percent of Troy Meadows and Great Piece, Little Piece, and Hatfield swamps. Conversions continuing; many wetlands zoned for industrial and commercial use |
| Dredge and fill | California—San Francisco Bay/tidal wetlands | Urban and industrial use | Conversion of 75 percent of original wetlands—60-percent reduction when considering wetlands newly created from sedimentation. Former diking of wetlands for agriculture and salt ponds. Pressure to develop diked historic wetlands for urban use. Most filling of current wetlands for nonwater-dependent development halted by Corps, San Francisco Bay Conservation Development Commission policies. Some conversions due to port and harbor development continue. About 50 percent of remaining wetlands preserved as refuges, parks. Preserved areas threatened with salinity increases due to upstream water diversions |
| Dredge and fill | California—southern coast/tidal wetlands, mostly salt marsh | Urban use, port construction, sedimentation from upstream development, oil exploration, marina development, higher real estate values in coastal areas | Conversion of 75 percent of all wetland areas. Of original tidal wetlands, 10 percent remain in Los Angeles and Orange counties. Continuing population growth. Continuing pressure to develop all 28 south coast estuary/wetland areas. About 40 percent of remaining acreage is protected. Regulatory programs of Coastal Commission and Corps have restricted some development and require compensation for other development |
| Fill | New Jersey-Hackensack Meadows/emergent wetlands | Waste disposal, urban and commercial development | Reduction in rate of wetland conversion. From 1950 to 1970, 3,000 to 3,500 acres filled. Conversion estimates since 1972 range from 495 to 1,200 acres, depending on definition used. Designated 3,576 acres for preservation. However, some wetlands initially designated for preservation were filled for sports complexes and turnpike exchanges. Other wetlands slated for nonwater-dependent development |

### Table 20.—Wetland Losses From Urban Development (Continued)

| How accomplished | Region/type | Reasons | Trend |
|---|---|---|---|
| Fill | New Jersey—Atlantic City | Residential and commercial development, highway fills, landfills, dredge material disposal | Substantial reduction in conversion rate since 1973 with State and Federal regulation. Continuing conversions from major public works projects (e.g., regional wastewater treatment plant, airport runway extension) that will likely include compensation. Continuing conversions also stemming from cumulative impacts of small projects (e.g., bulkheading). Limited protection for freshwater marsh areas |
| Fill | New England/coastal wetlands | Residential and industrial/commercial development, highway construction | Conversion rates probably reduced considerably due to increased effectiveness of State and Federal regulations. Some increases in wetlands acreage from agricultural abandonment |
| Drainage through ditches or dike construction and pumping; dredge and fill | South Florida/freshwater wetlands | Residential development | Continuing development in areas covered by Corps general permits for headwater areas. Development of plans to limit road construction and housing density in certain areas. Reduced rates of conversion in areas that are covored by Federal and State regulations. Conversion of wetlands to agriculture and subsequent conversions of agricultural lands to urban use |
| Fill, bulkheading, clearing, dredging, mowing, lowering water levels | Washington—Western lakes/freshwater marsh | Residential purposes: establish yards, beaches, boat access, lawns | Wetlands reduced on Lake Washington from 2,300 acres in 1902 to 1,400 acres in 1936. Since 1936, about 500 acres filled. Recent development activities generally require dedication of portion of wetlands for habitat preservation under State Shoreline Management Act |
| Fill | Alaska—urban areas, especially Anchorage and coastal towns of south-central and southeast regions/bogs, coastal marsh, and forested wetlands | Population increases, lack of alternative building sites<br>Road construction<br>Recreational development<br>Industrial developments | Wetland conversions limited to some areas to lower value wetlands through local wetland plans (Anchorage). Conversions in other areas not so limited |

SOURCE: OTA Regional Case Studies.

## Table 21.—Wetland Losses From Other Activities

| How accomplished | Region/type | Reasons | Trend |
|---|---|---|---|
| ***Forestry:*** | | | |
| Clearing, partial drainage, planting pine plantations | North Carolina/pocosins | Pulp and paper production.<br>Management to maximize forest growth | Continuing conversions—65 percent of remaining pocosin and other freshwater wetlands in North Carolina owned by agricultural and forest products industries |
| Clearing, planting hardwood plantations | Lower Mississippi River Valley/bottom land hardwoods | Pulp and paper production<br>Management to maximize forest growth | — |
| Selective cutting, partial drainage | North Carolina, lower Mississippi River Valley/bottom land hardwoods | Demand for hardwood products | Continuing drainage. Land of major forest companies in 27 eastern counties of North Carolina is 25-percent wetland |
| ***Mining:*** | | | |
| Excavation of limerock | South Florida/emergent marsh | Fill for construction, manufacture of concrete. Need to locate on edge of urbanized areas | Continuing conversion of wetland; however, projects are now designed for reduced impacts on fish and wildlife habitat, water quality, and hydrology as a result of Federal and State regulations. Some proposals in important wetlands denied when alternative sites available. Filling of previously mined sites for urban/commercial development |
| Excavation, water diversion, and clearing vegetation | California—desert conservation area/riparian vegetation | Availability of gold, minerals, and other materials (e.g., borax, potash, soda ash, lithium, sand, and gravel) | Continuing mining on an additional 25,000 acres, only a small percentage of which are wetlands and riparian areas |
| Excavation of phosphates, water diversion | North Carolina/bottom land hardwoods, fresh and salt marsh, pocosins | Recovery of phosphate ore for the manufacture of fertilizer products | Conversions continuing but at a variable rate, depending on general economic conditions and, especially demand for agricultural produce. Increased permit requirements for expansion of operations |
| Excavation and fill | Alaska/forested flood plain wetlands of Yukon region, northwest/wet tundra, southeast/forested flood plain wetlands | Availability of gold, copper, tin, platinum, antimony, mercury, and the like. Extensive mineral and coal resources in remote locations. Tailing disposal. Road and facility construction | Conversions continuing. Placer mining is not regulated under section 404 |
| Excavation of peat, water diversion (proposed) | North Carolina/pocosins | Synfuel development | State mining permits granted on 20,000 acres. No other permits required owing to limitation of $5\text{ft}^3/\text{s}$ by 404 program. Actual mining operation dependent on funding and possible support from Synthetic Fuels Corp. |
| ***Port development:*** | | | |
| Dredge and fill | Washington—Puget Sound—Puyallup River/brackish marsh | Port development | Continual conversion to port facilities 1880 to present. From 1880 to 1940, about 1,900 acres of vegetated wetlands filled. By 1980, only 14 acres original marsh remained |
| Dredge and fill | Washington—Grays Harbor/saltwater marshes | Port development, navigational dredging | Increases in intertidal flats and marshes and decreases in open water between 1890 and 1981. No wetland conversions from dredged material disposal since 1976. Proposed fill of about 90 acres of vegetated wetlands and 400 acres of intertidal flats as part of Grays Harbor Estuary Management Plan |
| Excavation, fill | Alaska/coastal wetlands | Harbors and canneries for commercial fisheries. Oil and gas terminals | Conversions continuing, losses, primarily related to oil and gas development |
| Fill | Washington—Puget Sound—Snohomish Estuary/brackish marsh | Industrial and port expansion.<br>More efficient earth-moving machinery—fill more economical than piers and pilings for foundations. Solid waste, wood waste, and dredged material disposal | Drainage and diking 9,000 acres for agriculture, 1880 to 1940. Port and industrial development since 1940. Landfilling urban waste 1965 to 1979 of about 200 acres. Other filling of less than 70 acres 1970 to 1980 (mostly wood waste, dredged material). Some breaching of dikes 1947 to 1970, increasing wetlands from agriculture |

## Table 21.—Wetland Losses From Other Activities (Continued)

| How accomplished | Region/type | Reasons | Trend |
|---|---|---|---|
| ***Road construction:*** | | | |
| Dredge and fill | New England/all wetland types | Highway development | Major source of wetland conversion from mid-1950's through early 1970's. Continuing construction in wetlands, but now generally designed to minimize wetland impacts; compensation sometimes included |
| Dredge and fill, drainage | Nebraska—Rainwater Basin/freshwater emergent marshes | Rural road improvements for safety and drainage to protect road subgrade-ditch cleaning, including some deepening and widening | Impacts on wetland from new road alinements minimal if Federal funding involved. Continuing wetland conversions associated with maintenance and improvements of existing roads (even if Federal funding is used). |
| Fill | Alaska—primarily North Slope/also south-central region—Kenai National Moose Range/wet and moist tundra | Access roads. Production and transport facilities and pipelines. Drill pad construction | Conversions continuing. Some secondary impacts now limited as a result of better understanding of how to prevent thermal erosion of permafrost |
| ***Transitions to nonwetlands:*** | | | |
| Erosion and sedimentation from offsite activities isolate wetlands from tidal influence | California—north and central coast estuaries/brackish marsh | Forestry, agricultural development practices in watershed | Conversions continuing. Greater use of BMPs in recent years should help reduce this problem; however, impact can continue for many years after sediment-releasing source is terminated, owing to material working its way down river channel |
| Erosion and sedimentation from offsite activities raise wetland elevations | Maryland Chesapeake Bay/freshwater marshes | Agricultural and development practices | Conversions continuing |
| Erosion and sedimentation from offsite activities fill isolated wetlands | Prairie potholes—Minnesota, North Dakota, South Dakota, Nebraska Rainwater Basin/freshwater marshes | Agricultural practices | Conversions continuing |
| Disposal of nonfill material (wood waste) | Western Washington, California/brackish and freshwater wetlands | Disposal of waste from timber harvest and forest products plants | Conversions continuing. Questions about regulatory authority |
| Disposal of nonfill material (garbage) | California—San Francisco Bay, New Jersey—Hackensack Meadows/brackish and freshwater wetlands | Landfills for urban waste | Continuing wetland conversions at existing sites. Questions about regulatory authority. Conversion rates expected to decline in future as site selection receives closer scrutiny at local level and alternatives for waste disposal are considered (e.g., energy recovery, composting) |

SOURCE: OTA Regional Case Studies

ulate these activities are discussed in chapters 7, 8, and 9. Further elaboration on the reasons for the major source of loss, due to converson to agriculture is presented following the tables.

## Agricultural Conversions

Information on Federal policy and national trends in agricultural land use was obtained from a working paper on agricultural policies prepared for OTA, except where other sources are noted.

### Trends in Agricultural Conversions

Eighty percent of freshwater wetland losses occurring between the mid-1950's and the mid-1970's were attributed to agricultural conversions, according to NWTS data. Only 2 percent of estuarine wetlands were lost to agriculture during this 20-year period. Conversions of estuarine wetlands to agricultural use were greater prior to 1950. For example, in the Snohomish Estuary of western Washington, conversion of wetlands to agricultural use was greatest prior to 1940 but continued to increase at a reduced rate until about 1960 (14). In California, diking of northern coastal wetlands for agriculture primarily occurred prior to 1950 (7). Since that time, many of the diked former agricultural areas have been filled for other uses. On the east coast, former diked estuarine wetlands used for agriculture have in many cases reverted back to estuarine wetlands or been maintained for nonagricultural purposes such as waterfowl production (13).

Although the general trend is the loss of wetlands to agriculture, there have been some relatively small gains in wetlands from former agricultural lands. Agriculture-related losses and gains of freshwater vegetated wetlands were 11.7 million and 899,000 acres, respectively. Similar losses and gains of estuarine wetlands were 9,000 and 2,000 acres, respectively. Some parts of New England actually had net gains in wetlands from agricultural land use. Some of these agricultural lands have reverted to wetland through lack of maintenance of former drainage ditches. However, the majority of abandoned agricultural areas have been converted to other nonwetland uses (17).

Wetland conversion to agriculture almost always involves surface drainage, but drainage may occur in areas that are not wetlands. USDA has prepared estimates of surface and subsurface drainage of all lands between 1900 and 1980. The data do not cover wetlands separately. By examining these drainage data in relation to NWTS estimates of wetland loss to agriculture between the mid-1950's and mid-1970's, it is possible to make some estimates of wetland loss to agriculture between 1975 and 1980 on a nationwide basis.

Pavelis (11) estimates that about 17 million acres, or about 850,000 per year, were surface-drained between 1955 and 1975 (table 22). During approximately the same period of time, NWTS estimates that 11 million acres of wetlands, about 550,000 acres/yr, were converted to agricultural land. This amount represents about 65 percent of the surface drainage. Between 1975 and 1980, just over 2 million acres, or about 426,000 acres/yr, were surface-drained. Even if all the drained lands were wetlands, the rate of wetland conversion (requiring surface drainage) has declined by at least 20 percent. However, if the proportion of drained wetlands to overall drained land has remained about 65 percent since 1975 the rate of *actual* wetland conversion to agricultural land would be about 275,000 acres/yr or about 50 percent of past wetland drainage rates. If gains in wetland acreage due to agriculture are proportional to those of the mid-1950's to mid-1970's, *net* conversion rates would be just over 250,000 acres/yr.

Interpretation of these nationwide figures may be somewhat misleading. In the past, drainage was concentrated in the Midwest, the Lower Mississippi River Valley, and the Atlantic and Texas coasts. More recently, although new drainage has been at a virtual standstill in many parts of the country, significant drainage activity still is taking place in the Lower Mississippi River Valley, Florida, and the Southeast in general (12). For example, data from the Lower Mississippi River Valley show that rates of clearing of bottom land hardwoods (which is often accompanied by drainage for crop production) continued to increase between 1967 and 1977 in Louisiana. Louisiana also had the greatest percentage of remaining forest in 1978. But in the five

Table 22.—Surface and Subsurface Drainage of Farmland, 1900-1980

| Year | Farmland currently drained | | Acreage shares | | Annual change, past 5 years | | Undepreciated drainage[a] | |
|---|---|---|---|---|---|---|---|---|
| | Surface drainage systems | Subsurface drainage systems | Surface drainage systems | Subsurface drainage systems | Surface drainage systems | Subsurface drainage systems | Surface drainage systems | Subsurface drainage systems |
| | (Millions of acres)[b] | | (Percent) | | (Thousands acres per year)[c] | | (Millions of acres) | |
| 1900 ...... | 5.271 | 1.024 | 83.7 | 16.3 | — | — | 3.975 | 1.014 |
| 1905 ...... | 9.775 | 1.902 | 83.7 | 16.3 | 900 | 176 | 7.447 | 1.877 |
| 1910 ...... | 18.673 | 3.632 | 83.7 | 16.3 | 1,780 | 346 | 15.313 | 3.572 |
| 1915 ...... | 29.344 | 5.701 | 83.7 | 16.3 | 2,134 | 414 | 25.029 | 5.541 |
| 1920 ...... | 43.452 | 5.993 | 87.9 | 12.1 | 2,822 | 58 | 38.131 | 5.573 |
| 1925 ...... | 41.420 | 6.143 | 87.1 | 12.9 | -406 | 30 | 41.412 | 6.143 |
| 1930 ...... | 42.676 | 6.687 | 86.5 | 13.5 | 251 | 109 | 38.514 | 6.010 |
| 1935 ...... | 38.606 | 7.244 | 84.2 | 15.8 | -814 | 111 | 32.697 | 6.118 |
| 1940 ...... | 36.532 | 8.905 | 80.4 | 19.6 | -415 | 332 | 19.298 | 4.711 |
| 1945 ...... | 40.769 | 9.555 | 81.0 | 19.0 | 847 | 130 | 15.800 | 3.291 |
| 1950 ...... | 57.980 | 11.949 | 82.9 | 17.1 | 3,442 | 479 | 22.849 | 5.394 |
| 1955 ...... | 64.995 | 13.670 | 82.7 | 17.3 | 1,443 | 344 | 29.172 | 6.510 |
| 1960 ...... | 70.784 | 15.823 | 81.7 | 18.3 | 1,117 | 431 | 34.252 | 7.550 |
| 1965 ...... | 76.013 | 17.630 | 81.2 | 18.8 | 1,046 | 361 | 35.244 | 9.048 |
| 1970 ...... | 79.753 | 19.331 | 80.5 | 19.5 | 748 | 340 | 21.773 | 10.426 |
| 1975 ...... | 82.563 | 20.817 | 79.9 | 20.1 | 566 | 297 | 17.588 | 11.912 |
| 1980 ...... | 84.715 | 22.768 | 78.8 | 21.2 | 427 | 390 | 13.931 | 13.863 |

[a] "Undepreciated drainage" refers to surface drainage systems in place for less than 20 years, to those subsurface systems in place for less than 30 years if installed before 1940, or to those subsurface systems in place for less than 40 years if installed in 1940 or thereafter. Note that by 1980 surface and subsurface systems were about equal in importance on an "undepreciated basis," even though surface systems are still in much wider use, as indicated by the acreages and percentage distributions for current drainage (cols. 1 to 4). Such a breakdown is useful as an overall indicator of general age and condition of farm drainage systems and was helpful for measuring active gross capital stocks and net capital values.

[b] Acreages for surface and subsurface drainage add to the overall net acreage drained.

[c] Rates of increase or decrease for surface and subsurface drainage add to the overall change for all farm drainage.

SOURCE: G. A. Pavelis, unpublished draft, "Farmland Drainage in the United States, 1900 to 1980: Acreage, Investment and Capital Values, 1982."

other States in the study region, clearing had peaked between 1957 and 1967. The study notes that "rates of acreage decreases in bottom land hardwood forest area closely reflect the magnitude of reduction in total hardwood forest area by State (10)." Thus, although national drainage *rates* have declined, wetland drainage probably is continuing in some areas.

## How Wetlands Are Lost to Agriculture

Wetlands are lost to agriculture through two primary means: direct conversions by draining and/or clearing and indirect conversions associated with normal agricultural activities. Direct conversions of wetlands for the purpose of expanding agricultural operations probably result in far more lost wetland acreage than do the indirect conversions on a nationwide basis. However, indirect conversions may be the major factor associated with loss of wetlands to agriculture in some regions of the country. Conversion activities are summarized in table 18.

Examples of direct conversion of wetlands to agriculture include drainage to expand crop acreage in the prairie-pothole region, construction of irrigation reuse pits to improve irrigation efficiency and to drain wetlands in the Rainwater Basin of Nebraska, clearing and draining bottom land hardwoods for soybean or rice production in the Lower Mississippi River Valley and for soybeans and other crops in North Carolina, and the mowing-chopping-seeding-grazing sequence for improving Florida sawgrass for agriculture.

Examples of indirect conversions of wetlands associated with normal agricultural activities include the general lowering of the water table for irrigation, which results in drying of "wet meadows," making them suitable for crops in the Platte River Valley and the Sandhills of Nebraska; changing water-management practices associated with crop changes in the Central Valley of California (i.e., when ricefields are converted to orchards, water from flooded ricefields is no longer available for discharge to wetlands); clean farming techniques

Photo credit: U.S. Fish and Wildlife Service

NWTS estimates that between the mid-1950's and mid-1970's 11 million acres of wetlands or about 550,000 acres/yr were converted to agricultural use through drainage and clearing

such as changes in rice-culture practices that result in fewer wetland species growing within ricefields; and changes in seed varieties and equipment that allow earlier planting and later harvests and tend to eliminate wetland vegetation that might grow in cultivated areas at other times of the year.

Individual permits under section 404 generally are not required for these direct and indirect conversion activities, either because they occur in areas covered by nationwide permits, are exempted under law, entail no dredge or fill activities, or involve incidental discharges or vegetation clearing that falls outside the Army Corps of Engineers guidelines for regulated activities. Even in cases where the Corps requires an individual permit, it is likely that the activity will be approved with few modifications due to difficulties associated with demonstrating adverse water quality and cumulative impacts from these activities. (See ch. 8 for further discussion of these issues.)

In the opinion of some agricultural analysts, the 404 program has had a minimal effect on the conversion of wetlands to agriculture or is viewed as being a modest nuisance, but not a significant hurdle for farmers. Although the importance of the 404 program varies in different locations, the Corps generally gets involved in response to a complaint or for very large projects. Monitoring potential agricultural conversion activities and enforcement of section 404 is not now considered possible, given the current manpower and budget of the Corps.

Economic factors (e.g., profits, available land, costs of maintaining wetlands) and Government policies often are cited as reasons for converting wetlands to agricultural use.

### ECONOMIC FACTORS

Commodity prices are a major factor in the decision to expend funds to bring wetlands into production. In some parts of the country, when prices are sufficiently high, it can be extremely lucrative to grow crops on wetsoils that may, but not necessarily, include wetlands. For example, in an analysis of minimum prices and potential yields for conversion of different wetsoils to soybean production in the southern Mississippi Valley alluvium, it was found that the minimum price for planting soybeans profitably ranged from $1.05 to $2.31 per bushel (bu) (5). With soybean prices ranging from a low of about $2.00/bu in 1958 to a high of over $7.00/bu in 1976, growing soybeans has been extremely lucrative (10). Production alternatives on these bottom land hardwood acres are not nearly as economically desirable as crop production. For instance sustained timber production from natural bottom land hardwood stands is not considered to be a viable economic investment. Hardwood plantations can produce good returns on some sites, but crop returns are better (10).

There is general agreement that the primary reasons for draining wetlands in the prairie-pothole region are the economic and technological factors associated with farming, including the:

- elimination of the nuisance and cost of avoiding potholes situated within cropland;
- opportunity to gain relatively productive cropland by draining wetlands (particularly if land is already owned);
- change in farming from a diversified crop-livestock combination to increasing emphasis on row-crop and small-grain production;
- rapid increase in tractor horsepower, which increases avoidance costs and facilitates drainage of potholes by providing the power to operate drainage equipment. This allows the landowner the opportunity to drain his own land during slack periods at low cost;
- continuing increase in the use of center-pivot irrigation systems that are not compatible with potholes;
- variable short-term climatic conditions that increase nuisance and cost factors in a wet year and provide opportunity for low-cost drainage in a dry year;
- short-term net farm income variability, which provides investment capital for drainage during periods of high income and increases the incentive to expand cropland area;
- absence of private returns from maintaining wetlands without Government programs; and
- low returns from Government incentives to preserve wetland relative to profits from conversion (6).

Pressures on agricultural lands from urban use (also an economic issue) may increase demands for agricultural land on wetlands in some parts of the country. For example, in south Florida, land use data for a single county between 1972 and 1980 showed that 23,767 acres of wetlands were converted to agricultural use while 655 acres were urbanized. During that same period, 24,539 acres of agricultural lands were lost to urbanization. Thus it appears that urbanization displaces agriculture, which then moves into wetland areas (1).

Costs of maintaining wetlands may be a factor in the decision to convert to agriculture in a few circumstances. For example, the California case study noted examples where hunting club landowners in the Central Valley found it too costly to maintain wetlands for waterfowl habitat because of local property tax policies. Wetlands were taxed as recreational lands at a higher rate than were agricultural lands. Costs of water and taxes have stimulated some hunt clubs to convert portions of their land for crop use (7); however, property taxes aren't considered to be a factor in conversion to agriculture in most other regions of the country. For example, in Nebraska, wetlands are taxed at a nominal rate (9).

The cost of direct conversions of wetland to agricultural use depends on the characteristics of the area to be converted. Relevant characteristics include how wet it is and for what period of time, the topography, the conversion technique used, and the availability of an outlet for drainage. Ownership of the areas to be converted and of equipment to perform the work also are factors in the cost. For example, the prairie-pothole case study cited six studies of costs of open drainage conducted from 1971 to 1981 by four different investigators. Costs per acre ranged from $11.24 to $400.00 (6). The Nebraska case study makes estimates of conversion costs for different methods for its analysis of the profitability of conversion. Conversion of Rainwater Basin wetlands (with an average size of 10 acres) to irrigated agricultural use with a reuse pit ranged from about $2,000 in 1965 to $6,600 in 1980 (9). Amortized costs over a 30-year period ranged from $12.95 to $84.99/acre/yr in 1965 and 1980, respectively (9). Estimates of landshaping costs in the Sandhills for irrigation vary with the terrain and range from $4,000 to $26,000/center-pivot (9). Converting pocosin wetland to cropland in North Carolina could cost as much as $740/acre (13).

Incentives from Federal programs (and in a few cases, State programs) to landowners to preserve wetlands are sometimes enough to outweigh the profitability of drainage and conversion (see following section). In many cases, however, payments from such programs as USDA's Water Bank Program and FWS easements are less than profits from conversion. A survey of landowner attitudes in Minnesota and North Dakota found that low payments from FWS and Agricultural Stabilization and Conservation Service (ASCS) programs were the overriding reason for refusal to participate in these protection programs (6). (Other important factors listed included the long period that the agreements cover and the lack of information about programs.) The Nebraska case study noted that wetland payments under the ASCS program of $10/acre and State habitat program contracts of $15 to $30/acre appear to be inadequate. To be successful, payments should be increased to the $35 to $45/acre range in Nebraska. The higher range would reflect not only the modest return that may sometimes be received by converting wetlands but also the partial value to society in preserving wetlands (9).

## NATIONAL TRENDS IN AGRICULTURAL LAND USE

The amount of total cropland planted nationwide declined between 1954 and 1972 from 355 million to 295 million acres. This decline was largely a result of production controls that were fairly constant throughout the 1960's. Some shifts of lands in and out of production did occur during this time, however. Land in major crops increased from 295 million acres in 1972 to 326 million acres in 1974 and then increased steadily until 1981, when 365 million acres were planted. (The year 1978 was an exception; there was a significant set-aside in that year, so land in crops decreased.) It is widely assumed by agricultural analysts that a major portion of the gains in planted cropland after 1972 came from areas that previously were idled by Government programs.

The nationwide expansion in cropland is attributed to the growth in export demand for grains and oilseeds that began in 1972. Primary factors for this increase in demand include the entry of the Soviets into the international market, a shortfall in crop production on the Indian Subcontinent, and the devaluation of the dollar in 1971. Major increases in commodity prices occurred between 1972 and 1976. Although the prices declined in 1977 and 1978, prices in general were sufficiently high during the late 1970's for farmers to increase their amount of land in crops.

The demand for new cropland is expected to increase over the next 20 years, despite expected advances in productivity. The amount of additional cropland needed will depend on the food needs of the United States, the production capability of U.S. soils, and the total export demand. Maximum estimates for cropland needed by the year 2000 range from 378 million to 437 million acres, depending on rates of increase in crop yields (4). Although USDA's National Resources Inventory identified an estimated 70 million acres of wetlands, the extent that wetland acreage will be used to meet this demand cannot be estimated readily.

Regardless of the availability of nonwetlands to meet future needs for cropland, demand for wetland conversions may well continue as a result of shifting the production of certain crops to different regions of the country. For example, estimates have been made that soybean production on existing cropland can be increased up to 21.5 percent in Louisiana and Mississippi without any environmental damage; destruction of scenic, recreation, and wildlife areas; lowered water tables; or water-quality degradation associated with conversions. Irrigation and precision land-forming would be required to make these improvements in production, and these techniques are being implemented on a fairly large scale. On the other hand, increased production costs of cotton in the West and Southwest associated with irrigation requirements and improvements in pest control may revitalize the cotton industry in the Southeast and in the Lower Mississippi River Valley, where cotton grows well on converted bottom lands with high organic matter.

Since data from the last 10 years are insufficient to provide an accurate estimate of current conversions of wetlands to agricultural use, future projections of wetland conversion rates cannot be made. However, without restrictions on conversions, it can be expected that wetlands probably will continue to be converted for agricultural use. Production on newly converted wetlands may have little impact on the national need for about 400 million acres of cropland over the next 20 years or even on regional incomes from farming. However, it may well make a difference for individual farmers.

# CHAPTER 5 REFERENCES

1. Center for Governmental Responsibility, "Wetlands Loss in South Florida and the Implementation of Section 404 of the Clean Water Act," University of Florida, College of Law, contract study for OTA, September 1982, p. 25.
2. Center for Wetland Resources, "Wetland Trends and Factors Influencing Wetland Use in the Area Influenced by the Lower Mississippi River: A Case Study," Louisiana State University, contract study for OTA, September 1982, p. I-28.
3. Council on Environmental Quality, "Our Nation's Wetlands: An Interagency Task Force Report" (Washington, D.C.: U.S. Government Printing Office, 041-011-0004509, 1978).
4. Council on Environmental Quality, "National Agricultural Lands Study, Final Report," U.S. Department of Agriculture, 1981.
5. Davis, B., "Economic Potential for Converting Woodland and Pasture to Cropland: Lower Mississippi Valley and Southeast," Economic Research Service, USDA ERS-495, Washington, D.C., 1972, cited in MacDonald, 1979, p. 56.
6. Department of Agricultural Economics, "Wetlands in the Prairie Pothole Region of Minnesota, North Dakota, and South Dakota—Trends and Issues," North Dakota State University, contract study for OTA, August 1982.
7. ESA/Madrone, "Wetlands Policy Assessment: California Case Study," contract study for OTA, September 1982, pp. 26-63.
8. Frayer, W. E., Monahan, T. J., Bowden, D. C., and Grayhill, F. A., "Status and Trends of Wetlands and Deepwater Habitats in the Coterminous United States, 1950's to 1970's," Department of Forest and Wood Services, Colorado State University, Fort Collins, Colo., 1983, p. 31.
9. Great Plains Office of Policy Studies, "Wetland Trends and Protection Programs in Nebraska," University of Nebraska, contract study for OTA, September 1982.
10. MacDonald, P. O., Frayer, W. E., and Clauser, J. K., "Documenting Chronology, and Future Projections of Bottom Land Hardwood Habitat Loss in the Lower Mississippi Alluvial Plain," Ecological Services, U.S. Fish and Wildlife Service, 1979, p. 133.
11. Pavelis, G. A., "Farm Drainage in the United States, 1900 to 1980: Acreage, Investment and Capital Values," unpublished draft, 1982.
12. Pavelis, G. A., personal communication.
13. School of Forestry and Environmental Studies, "Wetland Trends and Policies in North and South Carolina," Duke University, contract study for OTA, August 1982.

14. Shapiro & Associates, Inc., "An Analysis of Wetlands Regulation and the Corps of Engineers Section 404 program in Western Washington," contract study for OTA, September 1982, p. 16.
15. Shaw, S. P., and Fredine, C. G., "Wetlands of the United States: Their Extent and Their Value to Waterfowl and Other Wildlife," U.S. Fish and Wildlife Service Circular 39, 1956 (Washington, D.C.: U.S. Government Printing Office, 1971).
16. U.S. Department of Agriculture, "1980 Appraisal Part I: Soil, Water and Related Resources in the United States: Status, Condition, and Trends," 1981.
17. Water Resources Research Center, "Regional Assessment of Wetlands Regulation Programs in New England," University of Massachusetts, contract study for OTA, September 1982, pp. 17-18.
18. Wilen, Bill O., National Wetlands Inventory, Office of Biological Services, U.S. Fish and Wildlife Service, personal communication.
19. Wooten, H. H., "Major Uses of Land in the United States," U.S. Department of Agriculture, Technical Bulletin 1082, 1953.

# Chapter 6
# Impacts and Mitigation

Photo credit: U.S. Fish and Wildlife Service

# Contents

*Page*

**Chapter Summary** .......... **117**

**Introduction** .......... **117**

**Definitions** .......... **118**

**Development Activities** .......... **119**
Dredging and Excavation .......... 119
Filling .......... 120
Drainage and Clearing .......... 121
Extensive Flooding .......... 122
Water Withdrawals and Diversions .......... 123
Disposal and Discharge of Pollutants and Nonpoint-Source Pollution .......... 123

**Variables of Wetland-Impact Magnitude** .......... **124**
Physical and Chemical Variables .......... 124
Biological and Ecological Variables .......... 125
Operations Variables .......... 125

**Predicting Impacts of Development Activities** .......... **126**
Limitations .......... 126
Wetland Reviews .......... 127
General Permits .......... 128

**Mitigating Impacts** .......... **129**
Feasibility of Compensation or Offsite Mitigation .......... 130
Onsite Mitigation to Minimize Impacts .......... 131
Management Plans .......... 133

**Chapter 6 References** .......... **135**

## Chapter 6

# Impacts and Mitigation

## CHAPTER SUMMARY

Wetlands are important to development activities such as agriculture, forestry, port and harbor development, oil and gas extraction, housing and urban growth, mining, and water-resource development. Development activities that involve excavation (or dredging), filling, clearing, draining, or flooding of wetlands generally have the most significant and permanent impacts on wetlands. These impacts vary from project to project, depending on the scale and timing of the project, the type of wetland affected, and many other variables. Direct impacts associated with some development activities often can be mitigated by redesigning the project or modifying the construction timetable.

The ability to restore significantly degraded wetlands to their original condition depends on the type of wetland and on the degree to which it has been affected either by natural processes or by development activities. For example, San Francisco Bay wetlands that were once used for agriculture are being restored by removing manmade dikes that separated these wetlands from the bay. It is also possible to create new wetlands in areas that are not subject to a high degree of wave action or swift currents. Costs of creating new wetlands in relatively calm coastal environments range from as little as $250/acre to over $6,000/acre.

*The ability to construct new wetlands should not be used as sole justification for the unregulated conversion of wetlands to other uses:* manmande wetlands do not necessarily provide the same values as natural ones. In addition, it is probably not possible to create new wetlands at the rate they have been converted to other uses in the past.

## INTRODUCTION

Generally, any wetland-development activity of a significant magnitude has the *potential* to affect wetlands adversely. This chapter identifies the activities and operations that affect wetlands and describes the nature of their impacts. The actual impacts of an activity, however, are site and project specific. In other words, an activity with major impacts in one circumstance may have moderate impacts in another. All major development activities responsible for wetland loss, including those regulated under the 404 program, are included in this discussion.

The present ability to predict or monitor impacts on wetlands also is evaluated in this chapter. Impact assessment is a critical step in determining what development activities to allow in wetlands and how to mitigate potential impacts. The uncertainty associated with impact assessment influences both the ability to safeguard wetlands and the equity of regulatory decisions. On the one hand, wetlands require protection from project impacts that are not always obvious; on the other, regulatory decisions based on highly uncertain impact assessments may impose unnecessary burdens on developers.

Finally, opportunities for and limitations of mitigating impacts are evaluated in this chapter. Under the current regulatory program, mitigation conditions are imposed on about one-third of all permits processed annually; in comparison, less than 3 percent of all applications are denied. This suggests that the strategy of the 404 program is to minimize or compensate for impacts rather than prevent development.

# DEFINITIONS

The Council on Environmental Quality (CEQ) distinguishes between three basic types of impacts in the National Environmental Policy Act (NEPA) regulations:[1]

- *Cumulative impacts* are those impacts on the environment that result from the incremental impact of a development activity when added to other past, present, and reasonably foreseeable future activities. Cumulative impacts can result from individually minor, but collectively significant, activities taking place over time.[2]
- *Direct effects* are caused by specific activities and occur at the same time and place as the activities.[3] *
- *Indirect, or secondary, effects* are caused by the activities and are later in time or farther removed in distance but still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems.[4]

Impacts can also be described as *permanent* or *temporary,* and *short* or *long term.* The former distinction refers to whether or not the wetland restores itself naturally after suffering impacts; the latter indicates the length of time an impact takes to manifest itself after the activity occurs. An activity may have temporary and permanent impacts, as well as short- and long-term impacts, simultaneously. A canal dredged through a wetland area, for instance, will immediately damage a wetland by removing vegetation and wetland soil; this impact, in most cases, is permanent. The dredging, however, also will cause turbidity—generally a short-term, temporary impact—and slumping of adjacent wetland areas into the canal—potentially a long-term, permanent impact.

Two other terms used to describe impacts in this chapter are *onsite* and *offsite.* Activities can impact a wetland whether they take place directly on the wetland (onsite) or some place removed from the wetland (offsite). In general, offsite activities will have less immediate impacts than will onsite activities. Dredging in a wetland will remove vegetation and overlying substrata and cause immediate damage. Erosion of fill material disposed in areas adjacent to a wetland may cause gradual accumulation of sediment in the wetland over a longer time.

The term *mitigation* as used in the NEPA regulations includes:

a) avoiding the impact altogether by not taking a certain (i.e., activity) action or parts of an action;
b) minimizing impacts by limiting the degree or magnitude of the action and its implementation;
c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and
e) compensating for the impact by replacing or providing substitute resources or environments.[5]

---

[1] CFR title 40, pt. 325 to end, July 1, 1982.

[2] S. 1508.7.

[3] S. 1508.8.

*The words "effect" and "impact" are used interchangeably in both the CEQ regulations and this chapter.

[4] S. 1508.8.

[5] 40 CFR, pt. 1508.20.

# DEVELOPMENT ACTIVITIES

## *Dredging and Excavation*

Both dredging and excavation in wetlands involve the direct removal of wetland vegetation and the underlying wetland soil. Because the elevation of the dredged area is reduced, it normally will be flooded by deeper water most of the time, thereby eliminating the possibility of recolonization by wetland plants unless the area becomes subsequently filled, either naturally or by man. For example, dredging or excavation are responsible for wetland losses associated with agricultural conversion in Nebraska; mosquito-control ditching along the east coast in North Carolina; canal construction in coastal Louisiana, Mississippi, and Texas; peat mining in Maryland, Michigan, and Minnesota; phosphate mining in North Carolina and Florida; the extraction of other materials such as borax, potash, soda ash, lithium, gold, sand, and gravel; and port and other water-dependent coastal development.

Dredging commonly is used to deepen or straighten waterways for navigation, port, and marina facilities or for flood control. In addition to the direct effects of removing wetland vegetation and soil, dredging may impact wetlands even if it takes place offsite. Giese and Mello (21), for instance, found that dredging a navigation inlet into a small estuary increased the tidal range in the upper estuary, exposing the bottom at low tide. Salinity was increased, shellfish beds were exposed, benthic (i.e., bottom-dwelling) invertebrate populations were eliminated, and vegetation patterns were changed. The dredging of canals primarily for ac-

Photo credit: Office of Technology Assessment, Joan Ham

The dredging of canals for navigation and for access to oil and gas development sites in coastal Louisiana has led to saltwater intrusion into freshwater marshes. The excess salinity eventually kills the marsh vegetation cess to oil and gas development sites also has contributed significantly to direct and indirect wetland losses in coastal Louisiana (15). While many early studies attributed these losses to the presence of levees on the Mississippi River, which reduced the sediments contributing to the buildup of deltas and wetlands (8), several recent studies in the Mississippi Delta have shown a positive correlation between canal density and the extent of wetland loss (13,53). In addition to direct wetland loss resulting from the disposal of dredged material along canal banks, the increase in canal density in an area leads to more saltwater intrusion into wetlands as water is flushed in and out by the tides. Salinity changes may kill vegetation, and tidal flows help erode the banks of canals, causing them to widen at the annual rates of from 2 to 14.8 percent per year. At the high annual rate, a canal would double its width in only 4.7 years.

Excavation commonly is used for mining and to create dugouts, or reuse pits, for irrigation. Mining for minerals such as peat, phosphate, and limerock will cause total removal of wetland vegetation overlying these deposits (30). Additional adverse impacts also may result. For example, after limerock was excavated and removed from the Biscayne Aquifer in southern Florida, ground water filled the pits left by the excavation, lowering the water table. The stockpiling of materials, the construction of access roads, and other filling associated with development and operation of a mine also block surface waterflows. Water-filled rockpits, which are attractive locations for residential development, can become degraded quickly by urban runoff. In addition, water in the open pit is subjected to continuous, year-round evaporation (9).

In another example, the number and size of wetlands in the Rainwater Basin in Nebraska have been reduced through the excavation of "dugouts," or irrigation reuse pits. This practice results in partial drainage of some wetlands and the flooding of others (22). These wetland losses subsequently have led to increased incidence or risk of disease to waterfowl, reduction in food supply for migratory birds, and loss of breeding and rearing habitat for birds (22).

## *Filling*

The immediate and permanent effect of filling is to bury wetland vegetation, increase the elevation of the area, and eliminate the periodic inundation of the wetland (14). Several types of solid waste are used as fill material. Municipal waste, including household refuse and incinerator residue, has been used for wetland fills. Construction and demolition debris is used occasionally, as are stone, sand, gravel, and broken concrete from highway construction. Even coal ash has been disposed of as fill in wetlands (8). The disposal of some types of solid waste in wetlands carries the risk of detrimental chemical effects owing to leaching of nutrients and toxic chemicals from the fill material.

For example, filling is a major factor associated with wetland loss for land-leveling and agricultural conversion in Nebraska and California; for construction of impoundments in New England, the Lower Mississippi River Valley, Lower Colorado River Valley, South Carolina, and North Carolina; for canal construction and dredged-material disposal in coastal Louisiana, Mississippi, and Texas; for port, harbor, and other coastal development; for urban and industrial development in South Carolina, New Jersey, California, New England, south Florida, Washington, and Alaska; for road construction in Alaska, New England, and Nebraska; and for disposal of waste products in Washington, California, and New England.

Filling often is associated closely with dredging and excavation activities. For example, the major method used in the Southeast to create waterfront real estate has been to excavate canals within wetlands, using the dredged material as fill for building sites. This practice not only results in complete loss of the wetland but also creates canals that are poor habitat for both flora and fauna (26). A comparative study of a residential lagoon system and natural wetlands has shown that the lagoon supports smaller fish and shellfish communities (28).

Highways built on fill material can have indirect impacts by either flooding or dewatering adjacent wetlands. Culverts normally constructed at soil level will prevent flooding of the road, but will not allow the flow of subsurface water. In some instances, borrow canals adjacent to the highways also have diverted the drainage directly into a coastal estuary, permitting saltwater intrusion into the wetland where the normal drainage had been cut off.

## *Drainage and Clearing*

Narrow drainage ditches (less than 5-feet wide) may be excavated to accelerate and channel surface water runoff and to lower ground water levels, increasing the value of the drained land for agricultural and forest management. For example, draining and clearing is a major factor associated with wetland conversions in the prairie potholes and in Nebraska, California, the Lower Mississippi River Valley, North and South Carolina, and south Florida; for urban development in south Florida and Washington; and for forestry management in North Carolina and the Lower Mississippi River Valley.

The major ecological impact from draining and clearing wetlands for agricultural purposes is the loss of diverse wildlife habitat. Studies in Missouri where wetland channelization projects were undertaken to reduce flooding problems indicated that 78 percent of bottom land hardwood forest previously flooded was converted to crop production after project completion (19). In Louisiana, 51 percent of the original 4.5 million hectares of forested wetlands have been converted to agricultural use, mostly for soybean and cotton production. The loss of hardwood forests has meant a loss of prime habitats for birds and mammals, as well as a loss of critical spawning grounds for aquatic species. Under some circumstances, ditches in agricultural areas also may increase the runoff of pesticides, her-

Photo credit: Office of Technology Assessment, William Barnard

The clearing of this pocosin wetland in North Carolina will result in loss of wildlife habitat bicides, fertilizers, and animal wastes to downstream wetland systems. The drainage may change vegetation in adjacent areas; the runoff may cause pollution of adjacent land and open water areas (45). Drainage of wetlands for agricultural uses results in the loss of organic material from the soils due to oxidation. In some parts of the country, this may lead to soil subsidence and increased hazards of fire (9). For example, reclaimed peat-based agricultural land in the Sacramento-San Joaquin Valley has subsided through processes of compaction, oxidation, and wind loss and is now up to 20 ft below sea level (17).

In some instances, the creation of new habitats has changed the behavior of migrating birds; rice cultivation in southwest Louisiana and eastern Texas has encouraged overwintering of waterfowl that normally overwinter in eastern Louisiana wetlands. Natural filling of drainage ditches may cause an area to revert to a wetland, as occurred on some former agricultural lands in New England (56).

Forested wetlands are also partially drained to lower the water table and allow harvesting of the forested land. After harvesting, an area may be allowed to regenerate naturally or replanted as a pine or hardwood plantation. Active forest management can significantly increase the yield of wood from the land but also decrease wildlife diversity within forested plantations, depending on a number of factors. Maki, et al. (31) report that the practice of "high grading," in which only desirable large and shade-intolerant species are harvested, produces extensive stands of shade-tolerant species having less value as habitat. Large-scale drainage and channelization could contribute to decreases in resident invertebrate density and diversity (3). If good management practices are not used, constructing drainage ditches and channelizing streams in forested wetlands may also increase erosion and sedimentation, which in turn affects wildlife habitat and water quality in adjacent areas (7). In addition, the drainage of wetlands (14) may increase the danger of floods in downstream areas.

Drainage of wetlands in south Florida has been cited as contributing to flooding, drought, oxidation and subsidence of peat, saltwater intrusion, reduction of fish and wildlife resources, and water-quality problems in Lake Okeechobee—particularly increases in nutrients, suspended solids, and pollutants introduced from land uses to which wetlands are converted (9).

Grazing of livestock in wetlands has been a common practice because of the relatively rapid and lush growth of some wetland plants, particularly in arid regions. Some wetland vegetation has proved more nutritious for livestock than upland forage (38). Overgrazing leads to trampling and compaction of soft wetland soils and the loss of natural food sources for resident and migratory wildlife. Moderate grazing, on the other hand, can help maintain a wetland by encouraging the growth of annuals and by setting back vegetative succession.

Other agricultural practices, such as mowing, disking, and burning wetland vegetation to control crop weeds and mosquitoes, are often carried out in the playa basins of the southern Great Plains. The adverse effects of these practices are temporary and, like moderate grazing, can promote the growth of annual wetland vegetation (38). However, such practices conducted late in the growing season may severely curtail winter cover for upland game birds and waterfowl.

## *Extensive Flooding*

Permanently inundating wetlands to certain depths will eliminate wetland vegetation. Sometimes wetlands are flooded to create ponds for growing aquatic organisms, particularly fish and shellfish. Extensive flooding of wetlands is also associated with agricultural conversions of prairie potholes; development of impoundments for municipal- and agricultural-water supply, hydropower, and flood control in places such as New England, the Lower Mississippi River Valley, the Lower Colorado River Valley, Nebraska, and Alaska; waterfowl management in South Carolina; for mosquito control in North Carolina; and aquaculture in Louisiana.

Culture ponds for crayfish and shrimp, for instance, are prevalent in Louisiana. These ponds are constructed by building dikes to raise water elevations. In addition to its direct effects on the wetland vegetation, such flooding may have indirect effects on adjacent wetlands. For example, an experiment in shrimp culture, in which a dike was built to impound part of a coastal wetland, led to large variations in temperature and salinity with subsequent die-offs of many organisms, including the cultured species (41).

The construction of dikes or the disposal of spoil from dredging operations may result in the impoundment of swamps and marshes. An impounded swamp does not dry out periodically like a natural swamp and has a lower water turnover. This results in reduced primary and secondary productivity and decreased value for wildlife habitat. Virtually no fish are found in the stagnant water of such an area (10).

## Water Withdrawals and Diversions

Alterations in the hydrologic regime from large water withdrawals for municipal-industrial use or large-scale diversions of water for irrigation and flood control can cause various impacts on wetland ecosystems. The effects of these withdrawals and diversions on downstream wetlands are twofold. First, upstream depletions may lower the water table in downstream freshwater wetlands, causing a temporary or permanent loss of vegetation and a decrease in habitat values. Second, decreasing freshwater inflow in coastal areas will allow tidal incursion of saltwater into the brackish and freshwater marshes. The increase in salinity to these marshes will reduce species diversity and abundance as well as overall ecosystem productivity. Water diversions and withdrawals also reduce the input of detritus into the estuarine food chain.

Water diverted for irrigation and then returned to the wetland can increase salinities and temperatures considerably. For example, salinity in Suisun Marsh, which represents the largest contiguous wetland area in California and 10 percent of the total State wetland acreage, has been increasing along with increasing water diversions by the State and Federal water projects in the Central Valley and the Sierras. One result has been a decline in certain high-food-value plant species that are favored by brackish-to-fresh soil-water conditions. These brackish plant species are particularly important to wintering ducks and geese (17). In addition, increases in water temperature owing to thermal effluents from powerplants or from irrigation return flows may cause a reduction in species diversity of wetland flora or a shift to the more temperature-tolerant, blue-green algae that tend to produce eutrophic (oxygen-deprived) conditions.

Restricting or manipulating water flows with dams and reservoirs also can dewater downstream wetlands. Any wetlands downstream that are not immediately dewatered may be subject to reduced flushing, leading to a decrease in the amount of nutrients reaching the wetlands. Greater than normal floodflows can occur also when large reservoir releases are sustained, possibly washing out wetlands downstream.

Dikes and flood-control levees often are built to convert wetlands in flood plains to dry farmland. These flood-control levees retain floodflows within a river channel, dewatering the wetlands behind them. Levees within the floodway also tend to increase the velocity of storm runoff, produce an overall loss of flood storage capacity, and increase the chance of downstream flooding (45). Increased flows may increase scouring and erosion. Unlike the conversion of wetland by filling, land that is drained behind or within dikes or levees can be restored to a wetland if the embankments are removed or breached.

## Disposal and Discharge of Pollutants and Nonpoint-Source Pollution

Wetlands have been used to purify wastewater of nutrients and suspended solids, sometimes with adverse effects (4). Abundant nutrients in the waste may increase the productivity and biomass of tolerant vegetation in the wetland while more sensitive species disappear (58). Algal populations also may shift in species composition, which may lead to wetland eutrophication (23). If the wastewater volume is large enough to raise wetland water elevations, a conversion from emergent wetland to open water can occur. Stormwater discharge also can have adverse impacts on wetland functions and values. For example, contaminants from urban runoff have been noted to cause detrimental effects on tidal wetlands around Hilton Head Island in South Carolina (43).

A long-term effect of the disposal of contaminated dredge spoil in or near wetlands is the potential bioavailability of toxic chemicals such as oil and grease, pesticides, arsenic, and heavy metals, when the sediments are resuspended periodically (1). Although the bioavailability of these contaminants generally is quite low, under certain conditions there may be some long-term potential for bioaccumulation of these harmful substances within the food chain, especially when contaminated dredged materials are exposed to the air (27).

For example, filling of wetlands by eroded soil is also a factor associated with wetland conversions from forestry, agricultural, and development practices in watersheds of the California coast; from agricultural and development practices around the Chesapeake Bay in Maryland; and from agricultural activities in the prairie potholes and Nebraska.

# VARIABLES OF WETLAND-IMPACT MAGNITUDE

The actual impacts of a specified construction or development activity will vary geographically and by season of the year according to regionally or locally distinct characteristics of the physical-chemical environment. The characteristics of biological populations and habitats and of the whole wetland ecosystem also will modify the impacts. A discussion of these variables has been included here to illustrate both the site-specificity of wetland-project impacts and the range of factors that must be understood to make realistic impact assessments, and to suggest how these variables may be manipulated to mitigate project impacts.

## *Physical and Chemical Variables*

### Composition of Wetland Soils

The physical characteristics of wetland soils will have considerable influence on the severity of impacts produced by different activities in wetlands. Wetland bottom type is an important factor in species diversity and productivity. For example, a project that introduces large quantities of silt and clay would have a significant impact by smothering productive substrates. A wetland's chemistry also may influence the magnitude of a project's impact. The effects of dredging in marine or brackish waters are likely to be less severe than in freshwater because of the buffering capacity of these waters. Also, since cold water generally has higher levels of dissolved oxygen, the effects of activities that tend to deplete the dissolved oxygen will be greater if water temperatures are higher.

### Hydrologic Regime and Water Dynamics

The hydrology of a wetland will affect substantially the magnitude of impacts from activities in wetlands. For example, wetlands that are hydrologically isolated from ground water supplies, such as perched bogs or playa lakes, will be more adversely affected by excavation or dredging than wetlands that have sources of water besides precipitation. Excavation in these isolated wetlands may damage the compact peat layer and/or clay layers that seal the bottom of the wetland and hold water within it (32).

The construction of highways on wetland fill has different impacts, depending on the particular wetland hydrology. Culverts placed through a highway fill may cause flooding of the upslope side and dewatering of the downslope side (44). In the Florida Everglades, however, the same type of highway fill with drainage culverts may be able to accommodate the water that flows over the surface of the wetland.

### Composition of Fill Material

The disposal of solid wastes, however, carries the risk of detrimental chemical and biological effects due to leaching of the fill material. The magnitude of adverse impacts depends on the actual waste composition, which can vary physically and chemically according to geographic region, community standards, and seasonal variations. In general, municipal solid wastes have a high proportion of biodegradable animal and vegetable waste, rags, wood, cardboard and paper products, as well as ferrous metals. Leaching of organic matter such as garbage and wood waste can lead to an increased biological oxygen demand (BOD) and reduced levels or large fluctuations in dissolved oxygen (DO). Such changes in water chemistry can cause stress to aquatic populations and changes in species diversity.

## *Biological and Ecological Variables*

### Population Abundance, Diversity, and Productivity

Productivity, abundance, and diversity are important factors in evaluating the potential impacts of a certain activity on a wetland. Highly diverse wetland ecosystems with high overall productivity but low abundance of many species may be affected heavily by activities that change the limiting factors for selected species, thereby unbalancing the whole structure (species composition) of that ecosystem. A less diverse ecosystem may be impacted less by the same activities. *Spartina* marshes, which almost can be considered a monoculture, are known to be highly resistant to changes in salinity and might not be affected significantly by, for example, the reduction of freshwater inflows to the estuary from upstream use of water for cooling a powerplant.

### Presence of Key Species Important to an Ecosystem

The severity of impact from a particular activity will be greater if the adverse effects focus on a key species in the wetland ecosystem. For example, detritus-based food chains can easily be disrupted by activities that would lower the abundance of snails and small crustaceans that help produce detritus by shredding the marsh grasses.

### Habitat Diversity and Carrying Capacity

Fish and wildlife may require different habitats during their lifecycles, in each season, and even daily, in order to meet their needs for food, water, cover, and reproduction. Wetlands offer a variety of habitats for a variety of species and life stages. Habitat diversity often has been assessed as an indication of the importance or health of a wetland. The degree of impact on a wetland often will depend on which habitats are adversely affected; for example, fish that use coastal marshes may be diverted from their normal routes by large changes in salinity and flow (24).

## *Operations Variables*

### Frequency, Duration, and Season of Activity

The frequency, duration, and season of a development activity in or affecting a wetland will modify the severity of impact. Frequent channel-maintenance dredging, for example, might limit the recovery of an adjacent wetland from the temporary effects of sediment resuspension, especially where there is high exposure to wind and waves. Oil exploration may have rather minor and temporary adverse effects on waterfowl if access to wetlands is limited during the breeding, nesting, and rearing season. Similarly, construction of a highway through a wetland will have less impact on water quality and wildlife if the construction is rapid and efficient, avoids the period of high spring runoff, and is carried out before or after the waterfowl breeding season.

### Location of Activity Within an Ecosystem

The location or orientation of development projects within a wetland can alter the magnitude of their impact considerably. One example would be the placement of highway fill in a wetland. If the causeway fill is placed parallel to the direction of surface sheet flow and subsurface flow, the problems of blocking wetland drainage or channeling the flow through culverts will be minimized (44). In another example, if pipelaying in wetlands is confined to the "push-ditch" method and the equipment can operate on dry soil at the edge of the wetland, the impacts will be less than if the equipment is operated from mats in the wetland.

### Distribution, Scale, and Type of Activity

The type, scale, and spatial distribution of construction or development in a wetland must be considered in order to estimate reliably the project's impact. Wetland filling, if confined to a single area of marsh while leaving other areas undisturbed, may be preferable to a patchwork of fills distributed throughout the marsh. Draining and clearing of a significant number of small, isolated wetlands for cropland have contributed to the decline of waterfowl in the Central and Mississippi flyways (35).

# PREDICTING IMPACTS OF DEVELOPMENT ACTIVITIES

## *Limitations*

According to U.S. Army Corps of Engineer regulations, "the decision whether to issue a permit will be based on evaluation of the *probable* impact, including cumulative impacts of the proposed activity . . . ." Under the Corps' public interest review, the impacts of a proposed project must be weighed against its other costs and benefits to determine if the project will be allowed. While there are certain characteristic impacts associated with particular activities, it is clear that the actual impacts of any project will vary with each site and project and will depend on the time at which they are conducted. This suggests that in most cases similar activities or projects cannot necessarily be regulated in a uniform way; the potential impacts of major projects that might generate significant impacts must be evaluated on an individual basis.

Guidelines established for the 404 program recognize the variability that exists from site to site and project to project. The 404(b)(1) guidelines, for instance, require that the "permitting authority . . . shall determine in writing the potential short-term or long-term effects of a proposed discharge of dredged or fill material on the physical, chemical, or biological components of the aquatic environment." This includes determinations of the nature and degree of effect that a proposed discharge will have on the following: physical substrate, water circulation, fluctuation and salinity; suspended particulates/turbidity; contaminants; the aquatic ecosystem and organisms; and cumulative and secondary effects.

Even under conditions of very careful site-specific and project-specific examination, however, the ability to assess potential impacts accurately often is limited. In general, the immediate effects of an activity are easier to predict than long-term impacts; physical-chemical impacts are more predictable than biological impacts; direct effects are more apparent than secondary effects; and the impacts of each project individually are much easier to predict than the cumulative impact of many individual projects. The short-term turbidity caused by dredging, for instance, is predicted relatively easily and precisely; predictions of most cumulative impacts are merely speculative. A study of the impacts of deepening navigational channels on fish and wildlife concluded that:

> Assessing the impacts of navigational dredging and the disposal of dredged material is a controversial exercise; the viewpoints and approaches are endless. Without question, dredging can devastate fish and wildlife resources; however, in the absence of definitive information, impacts are sometimes more imagined than real (1).

It is well recognized that the routine application of section 404(a) authority to issue individual permits for the discharge of dredged or fill material cannot provide for the assessment of cumulative impacts on wetlands or other aquatic resources from many individual projects that are evaluated separately. The Corps' proposed general policies for evaluating permit applications makes a clear declaration:

> Although a particular alteration of wetlands may constitute a minor change, the cumulative effect of numerous such piecemeal changes often results in a major impairment of the wetland resources.[6]

The separate examination of potential effects at different but interrelated wetland sites cannot, by itself, account for the cumulative effects. The Corps' Environmental Advisory Board concluded that:

> Individual permit processing in specific regions is costly and ineffective in addressing the cumulative impacts of existing and future similar permit

---

[6] *Federal Register*, vol. 45, No. 184, pp. 62, 740.

actions in the same region. There was general agreement that without planning, the cumulative impact of activities associated with the regulatory program could indeed lead to serious consequences. Planning required to assess cumulative impacts of individual actions must be done on a large scale—regional, watershed, ecosystem, etc. It was also generally agreed that any analysis of cumulative impacts on an area must of necessity be based on a knowledge of local growth patterns and local planning objectives.[7]

## *Wetland Reviews*

As noted in the Code of Federal Regulations,[8] "the District Engineer may undertake reviews of particular wetland areas . . . to assess the cumulative effect of activities in such areas." Some districts have conducted such inventories of wetland resources, called "wetland reviews," particularly where there are large numbers of permit applications and pressures for development. In some cases, the Corps has worked with State and local officials to plan for future demands for development that might require section 404 authorization. Such activities also can help to reduce the time it takes to make a permit decision and to reduce uncertainty as to which areas are regulated under section 404. These efforts are described below.

Wetland reviews have been conducted for at least six estuaries on the west coast, one area in Alaska, and in the Atlantic City, N.J., area. Each review is different; however, the review of the Snohomish Estuary by the Seattle District in 1977-78 provides a good example of information that can be presented to help reduce the uncertainty associated with the 404 process. The review's goal was to provide a comprehensive inventory of wetland habitats, a discussion of existing regulatory controls, and recommendations for wetland protection. As part of the project, a complete inventory and mapping of land use and land cover was prepared. In addition, fish and wildlife habitats and physical, cultural, and esthetic characteristics were mapped and evaluated.

From the data gathered, wetland areas within the estuary were designated as areas of importance, areas of environmental concern, and other areas. Areas of importance were those areas with unique resources or those which served critical functions. It was recommended that they be maintained in their present state and that any 404 permit be approved "only if the activity is clearly in the public interest." Areas of environmental concern were sensitive to development or change, but might have uses that are "consistent with maintenance of their habitat values." It was recommended that "only uses in the public interest and compatible with the habitat values should be approved." Other areas were those in which "new development would have minimal impacts on wetlands and other valuable habitat types."

Since its completion, the Snohomish Estuary Wetland Study has been used regularly by the Seattle District. Within the Regulatory Functions Branch, use of the document has emphasized the identification of wetlands as a means of determining Corps jurisdiction under section 404. As a result, the need for time-consuming site visits has been reduced. It also is used in preapplication conferences to inform applicants of issues of concern and to suggest methods for minimizing impacts associated with their proposal. In the Environmental Resources Section, the analysis of wetlands values has been used in preparing environmental assessments (EA's) of proposed 404 permit activities. The detailed data base presented in the review saved both time and effort in preparing environmental documentation. Furthermore, in the winter it provides data that would not be available even on a site visit. On occasion, the review even has been used as a data source for EA's on sites in other estuaries with similar habitats.

It should be noted that the Snohomish County Planning Department also uses the study to evaluate substantial development permits under its Shoreline Master Program. The small county staff lacks the technical expertise to evaluate all the functional characteristics and potential impacts associated with a particular site; the review contributes to the accuracy and consistency of their decisions. In addition, the important wetlands that were identified in the study have been incorporated as "areas of special concern" in the county comprehensive plan (45).

---

[7] U.S. Army Corps of Engineers, 29th Meeting of the Environmental Advisory Board, held Apr. 21-24, 1982, Arlington, Va.

[8] 33 CFR 320.4(6)(3).

## General Permits

### Advantages

In 1977, Congress authorized the Corps to exempt categories of activities "similar in nature" on a nationwide, districtwide, or statewide basis from case-by-case permit reviews. The Corps is required to establish that activities regulated in this way "will cause only minimal adverse environmental effects when performed separately and will have only a minimal cumulative adverse effect on the environment." Regionwide and nationwide general permits provide several positive features for wetland regulation. They provide regulatory consistency, avoid administrative delay and paperwork, and circumvent possible duplication of control by other agencies. Myhrum (34) notes that the nationwide permit program allows the regulatory agencies to focus limited personnel and finances on activities generating greater impacts. Twenty-five nationwide permits for categorical activities, such as shore stabilization and minor road-crossing fills, have been authorized with special conditions attached to each that must be followed in order for the permit to be valid. Division engineers of the Corps are authorized, at their discretion, to modify nationwide permits by adding regional conditions applicable to certain activities or geographic areas. Further, individual permits may be required if general permits are not adequate to protect aquatic ecosystems.

While section 404 authorizes general permits for activities similar in nature, the Corps also has authorized two general permits on a nationwide basis for areas rather than activities. The Corps' justification for this goes back to its history of using general permits on an areawide basis, before the 1977 amendments authorized general permits officially. The Corps also argues that the areas granted general permits (isolated waters and waters above headwaters) have not been regulated in the past and that the geographic scope and distribution of these waters make them impossible to regulate effectively on a case-by-case basis. On the other hand, granting a permit on an areawide basis, rather than on an activity basis, allows activities and projects to take place on wetlands, regardless of the scope and magnitude of their impact.

### Disadvantages

Despite these advantages, Blumm (5) has expressed the view: "Absent reporting requirements, the cumulative impacts of general permits remain largely a matter of speculation." He cites the criticism by the General Accounting Office (GAO) of cumulative impact assessment by the Corps in a GAO 1977 report: "It is not clear that our foundation of knowledge about impacts can support the premise that activities or discharges and conditions specified under nationwide permits will *necessarily* ensure minimal adverse impacts, particularly minimal *cumulative* adverse impacts." For example, minor road-crossing fills are permitted in nontidal wetlands if they discharge less than 200 cubic yards below "mean" high water and do not extend beyond 100 ft past the ordinary high water mark. Each such fill is required to be "part of a single and complete project for crossing of a nontidal waterbody . . ."[9] However, successive "minor" crossings of a road over many isolated small freshwater wetlands in the Great Plains or separated narrow riverine wetlands in a coastal delta cannot always be said to involve only minimal cumulative impacts. While the Corps is required under section 404(e)(2) to review the status of nationwide permits every 5 years to determine if impacts have been minimal, it is almost impossible to assess the impacts that have taken place as a result of the permit if reporting is absent. In light of this problem some general permits now have reporting requirements and additional reporting requirements are being considered for others.

Another difficulty with general permits is that it is difficult for some developers and landowners to determine if they meet the conditions of the permit. To meet the general-permit conditions, for example, that a discharge of fill in an isolated wetland does not adversely modify the critical habitat of a threatened wildlife species requires a high level of technical expertise. Parish and Morgan (40) discuss this problem:

---

[9] *Federal Register*, vol. 45, No. 184, pp. 62, 776.

> Lack of certainty is inherent in the language of the permit conditions. A discharge will be permitted if it consists of "suitable" materials free from toxic materials, and the fill will be "properly" maintained. Certain classes of activities will be permitted if management practices are followed to the extent "practical" and adverse effects are minimized. If the discharger incorrectly interprets any of these terms and an individual section 404 permit is required, its issuance will involve the need for federal environmental assessment.

# MITIGATING IMPACTS

In line with the definitions used by CEQ, mitigation includes:

- avoiding adverse impacts to wetlands altogether by denying a project permit;
- minimizing impacts by limiting the degree or magnitude of a project;
- rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
- reducing or eliminating the impact on wetlands by preservation and maintenance operations during the life of the project; and
- compensating for the wetland losses by replacing or providing substitute resources or environments."[10]

For the purposes of the following discussion, a basic distinction can be drawn between those actions taken to *minimize* the impacts of a project on wetlands and those actions taken to *compensate* for a project's impact. Though the two may be used in combination, the strategy to compensate is most suited to situations where little can be done to minimize project impacts. Typically, in such a case, the project totally eliminates the wetland and compensation entails either restoration of wetlands or creation of new ones at another site. Filling and bulkheading of wetlands for real estate development or draining and clearing of wetlands for farming are good examples.

Under the 404 program, adverse impacts are reduced by *conditioning* individual permits or by using "blanket conditioning" for general permits. Conditioning usually entails either onsite design requirements and construction and management practices to minimize impacts or requirements for offsite compensation of unavoidable impacts. Like the difficulties associated with assessing impacts, the effectiveness of mitigation measures in ameliorating the impacts of a project sometimes can be very uncertain or even speculative. Although the Corps strives to tailor mitigation measures to individual permits, controversies may arise from requirements for expensive mitigation measures if the benefits of these measures are questionable. In some cases, the expense of mitigation can reduce the profitability of projects to a point where they are no longer worthwhile to pursue, and developers complain that the agencies sometimes use permit conditions as leverage to discourage projects.

Current Corps policy does not give much guidance on the level of mitigation appropriate in cases of great uncertainties, calling only for modifications that are "commensurate in scope and degree with the impacts of concern." However, the Corps currently is establishing a more specific policy: in the interim final regulations issued July 22, 1982, the Corps indicates that it is beginning to address the problem of uncertainty. Whether permits may require mitigation of secondary impacts, for instance, "will depend on whether the impact is at least probable, rather than speculative."[11] In its May 12, 1983, revisions of the 404 regulations, the Corps proposed expanding authority of the district engineer to provide for either onsite or offsite mitigation.

In the following sections, the feasibility of these strategies is evaluated, and opportunities for and limitations of using them are explored.

---

[10] CFR, pt. 1508.20(a-e).

[11] *Federal Register*, vol. 45, No. 184, pp. 62, 657.

## Feasibility of Compensation or Offsite Mitigation

### Creation

Producing a new wetland usually involves filling an open-water or upland ecosystem, which may, in itself, possess important values. Developing a new wetland entails providing the proper substrate level and type, assuring chemical compatibility, and providing erosion control during establishment of vegetation. The complexity of these factors introduces considerable risk of failure; however, the historical record shows that creation of wetlands can be successful, given proper site selection and preplanning.

Marsh creation has occurred mainly in coastal waters or along shorelines that are not exposed to large storm waves or the wakes of ships (20,39,60). Planting aquatic plants predates the 1940's. Marshes of various sizes have been developed along the Mississippi River since the 1930's, in Utah in the 1930's and 1940's, and in Wisconsin and other States since the 1940's. Although some projects range up to several hundred acres in size, marsh creation by means of artificial plantings tends to be on a smaller scale (0.1 to 10 acres) owing to high costs for establishment.

The largest concentration of projects has occurred in brackish and saline environments along the mid-Atlantic and Southeastern coastlines. Wetlands also have been created successfully in New England, along the Gulf Coast, particularly in Texas (57), and along the west coast [e.g., San Francisco Bay and the Columbia River estuary (51)]. Some freshwater marshes have been established on rivers (55), on the Great Lakes (59), in isolated ponds as part of surface-mine reclamation (11), and in sewage lagoons, to assist with wastewater treatment (16).

### Restoration of Wetlands

Restoration involves taking an existing marsh from a poor, unhealthy, or degraded state to the level of productivity and habitat value associated with undisturbed natural wetlands occurring in the vicinity. This process often can be accomplished by changing surrounding water inflow or drainage, eliminating erosion and siltation, and reducing pollution from adjacent areas (6,29,46). Restored areas generally will have at least some semblance of the natural elevations and substrate unless erosion or sediment deposition has been severe. Residual populations of natural plants usually are present to serve as seedstock for widespread regeneration. However, re-creation of wetlands has occurred from seed remaining in the soil for decades.

Restoration, although not widely reported, has been practiced in estuarine systems where diking has degraded coastal wetlands (33,47), in areas where normal sediment input or hydrologic patterns have been disrupted (48,49), and in brackish or saline marshes that have been modified heavily by construction activities or exposed to different types of pollutants (55). In some cases, freshwater wetlands have been restored, as in the case of Florida's extensive freshwater ecosystems (50,52). Marsh-restoration projects tend to be small—usually 20 acres or less.

### Costs of Creation and Restoration

Any successful marsh-creation or marsh-restoration project must involve costs for project planning, site investigation, careful seasonal scheduling, and postproject monitoring. Total project costs typically range from $250/acre for a small, relatively simple marsh-creation project (57) to over $6,000/acre for a marsh established for sewage treatment (16). Transport of substrate material by barge, truck, or dredge, and subsequent site preparations usually account for the largest single cost wherever the site requires extensively raised elevations. In most newly created wetlands, artificial plant propagation is also a necessary and significant cost. Scheduling of project operations within natural environmental constraints, such as the periods of tides, plant germination time, and limits of the growing season can increase costs in the short term but will contribute greatly to project success over the long term. In general, it is far less costly to restore degraded wetlands than to create new wetlands.

### Prospects for Success

The success of efforts to create or restore wetlands depends on many factors, including wetland type and location, project scope and size, materials and methods used, and good project planning and management, especially during the first two or three growing seasons. However, even a properly developed wetland will require an extended period of time for the functions of a natural wetland to evolve. For example, hydrological values and the ability of manmade wetlands to enhance sedimentation of suspended material are achieved within a relatively short time; wetland ability to assimilate nutrients and toxic substances takes somewhat longer. The diversity of a site and its ability to support more wildlife also generally increase over time. However, there is insufficient data at this time to say how long it takes for all the biological functions of a natural wetland to develop.

### WETLAND PRESERVATION VS. RESTORATION OR CREATION

Some States may call for *protecting* wetlands equivalent in biological value to the wetlands filled or diked. Others, such as Oregon, prescribe that no net loss of existing wetland values should occur: "Oregon's mitigation requirement . . . is that areas of similar biological potential must be *created or restored,* not simply protected (25)." The mitigation goal is to replace lost wetlands with restored or new wetlands similar in quantity and quality of flora and fauna. Recently, the concept of "no net loss" has been criticized. The skepticism arises from a concern over whether new marsh creation really compensates for losses of natural wetlands. Race and Christie (42), for instance, write:

> A reevaluation of data from manmade marshes is necessary before there can be a determination of whether coastal salt marshes are truly being replaced or expanses of marsh vegetation that persist temporarily are merely being planned . . . a newly created marsh is not the functional equivalent of a 1,000-year-old marsh.

These authors warn that mitigation should not be offered as justification for the development and destruction of wetlands. The assumed ability to "create" wetlands, they say, creates the perception that wetlands are a renewable resource, a perception that could lead to more widespread development. Regulators, they feel, should be "judicious" in allowing mitigation by marsh creation. Race and Christie conclude that:

> Marsh creation in suitable situations can be an effective tool to minimize onsite damage at post-construction sites, to abate shoreline erosion, and to return degraded wetlands to tidal influence by means of restoration. However, because of the limited scientific evidence on the development and stabilization of important biotic and physical characteristics of manmade salt marshes, managers must be cautious in the widespread adoption of marsh creation as a mitigation strategy.

### OPPORTUNITIES FOR WETLAND MITIGATION BANKING

The Statewide Interpretive Guideline for Wetlands and Other Wet, Environmentally Sensitive Habitat Areas, adopted pursuant to the California Coastal Act, provides for the payment of a fee to a public agency for purchase and restoration of a degraded wetland to a productive value at least equivalent to that of a wetland being filled. The payment to a "mitigation bank" would be in lieu of dedicating or restricting the use of a comparable wetland provided directly by the permitholder (36). This feature relieves the burden on landowners and developers of searching out suitable mitigation sites. It also promotes a cohesive rather than a fragmented approach to wetland-impact mitigation, with significant opportunity for economy of scale.

A Federal wetland bank, as suggested by the Corps, would operate as in California except that creation of replacement wetlands would be emphasized (54). In fact, Congress has authorized use of a wetland mitigation bank associated with the Tensas project in Louisiana.

## *Onsite Mitigation to Minimize Impacts*

### Site-Specific Requirements

Many development activities produce *primary, secondary,* and *cumulative* impacts in or adjacent to wetlands that can be minimized feasibly when fully understood. Thus, successful control of the primary impact, in turn, will reduce subsequent secondary and cumulative impacts. Further mitigation efforts may be necessary, however, where an activity is known to produce significant indirect or compounding adverse effects. An areawide wetland review may uncover further unforeseen impacts.

One of the major problems in mitigating project impacts is the difficulty of mitigating cumulative and secondary impacts. The lack of reliability in impact prediction complicates the mitigation process. As an example, a short-term, isolated, primary impact of a dredging operation is suspension of sediment in the water column. The narrow approach toward mitigating this effect might include avoiding periods of fast tidal currents and deploying silt curtains. However, secondary impacts may include the release of excess nutrients and toxic contaminants. Long-term cumulative impacts from repeated dredging and other excavation at many sites throughout a single estuary might include low-level but widespread, bioconcentration of metals and synthetic organic compounds, with consequent chronic, sublethal effects within the food chain. Mitigative measures designed merely to minimize the direct, localized effects of separate dredging operations may fail to address systemwide, indirect effects.

## General Requirements

Mitigating impacts on wetlands may take the form of standard conditions attached to individual dredge or fill permits, conditions incorporated into general nationwide and regional permits, and the best management practices (BMP's) prescribed for activities exempted from any permits. While the nature of general prescription has eased the regulatory burden of issuing individual permits covering site-specific situations and has set approximate standards for common development practices, it overlooks the likelihood of environmental damage that may occur because specific wetland functions, values, and sensitivities are not considered. As an example, disposal of spoil from maintenance dredging might be required under a regional general permit to avoid discharge in or near active currents. This practice could lead to several shallow-water spoil sites in a wetland area with long-term effects, such as chronic resuspension of sediments from wind and waves, periodic disruption to bottom-dwelling populations, and possible bioaccumulation of toxic chemicals (37). Under an individual permit, however, site-specific conditions might stipulate long-term disposal within a diked containment site to avoid contamination of a nearby wetland heron rookery or of a municipal ground water supply.

BMP's are applied to common activities such as minor road construction for maintenance of natural surface and subsurface drainage or pipeline installation for sediment control. A representative BMP for a minor road might be to install culverts through the causeway fill with spacing, elevation, and capacity needed to maintain lateral drainage, including stormflows and the passage of fish and other aquatic animals (37). The application of BMP's on an indiscriminate basis can reduce the effectiveness of mitigation measures by overlooking limiting, site-specific conditions. To ensure their effectiveness, adequate site investigations are necessary to show that critical or sensitive wetland values and functions are not jeopardized and that local environmental conditions will not negate normal BMP effectiveness. For example, where there is unchanneled sheet flow in a marshland, the required number and spacing of culverts will be quite different than where surface flow is already channeled; otherwise, the usual BMP approach could cause adverse hydrologic impacts by promoting channeling. In conclusion, BMP's generally are appropriate where impacts from a specified activity are localized, consistent, and predictable; the mitigative measures are highly standardized and proven effective; and the landowners or developers responsible possess the necessary technological and management capabilities to use these practices effectively.

Controversy over mitigation arises over application of blanket stipulations of mitigation requirements as opposed to case-by-case tailoring of permit conditions. Blanket stipulations greatly increase the uncertainty over the effectiveness of mitigation requirements, and developers complain that they are required to meet blanket stipulations that are not applicable to their specific permit situation. Because it lacks resources to undertake the extensive site investigations or studies to determine the effectiveness of different mitigation measures, the Corps has been forced to use stipulations recommended by its staff and staff from other resource agencies. GAO, in a report to the Congress on improving wetlands permit processing in Alaska, concluded:

> (The) Corps imposes controversial and costly permit conditions without assuring that these conditions are, in fact, needed. The need for these conditions, which are frequently proposed by various Federal and State agencies, is not substantiated by site-specific data and research findings (12).

GAO recommended increased site-specific investigation to prescribe impact controls adapted to unique site characteristics instead of blanket stipulations. This recommendation was aimed at the uniform application of particularly costly measures that may burden the oil companies, such as seasonal drilling requirements in wetlands. However, GAO admitted that without more research to substantiate such restrictions, neither their imposition nor the removal of blanket restrictions could be justified.

### Uncertainty of Mitigation Cost Effectiveness

In the Corps' proposed regulations for processing of section 404 permits, special conditions may be attached "only to respond to effects and impacts of the permit which are at least probable rather than speculative.[12] Banta and Nauman (2) believed that, "While ideally (mitigation) involves an objective judgment by scientific standards . . . , it has frequently become the last ounce of environmental quality that can be injected into a project within legally and politically acceptable limits." For example, a standard mitigation criterion in the Environmental Protection Agency's (EPA) section 404(b)(1) guidelines is to minimize adverse effects by "selecting sites or managing discharges to prevent or avoid creating habitat conducive to the development of undesirable predators or species which have a competitive edge ecologically over indigenous plants or animals." This much sophistication actually applied to the conditioning of permits would entail considerable subjectivity and speculation.

Clearly, there is more objectivity and accountability where mitigation is prescribed in more specific terms tailored to local conditions, or at least to regional situations. On the other hand, a total site-specific approach would impose an inordinate regulatory burden on both the permitters and permitholders. Mitigation may not be cost effective where, as GAO has pointed out, costly measures for wetland protection are requested without a site examination to ascertain the need in each case. Also, requesting untested or (experimental) practices for impact mitigation may be insupportable in view of the proposed regulation to eliminate conditioning of permits for speculative impacts. Unfortunately, the followup evaluation of actual cost effectiveness for classes of mitigative measures has been very deficient.

## *Management Plans*

To design a mitigation plan covering secondary and cumulative impacts in an area subject to significant development activities, a systemwide impact assessment such as that provided by the Corps' "wetland review" must be undertaken prior to developing an estuary management-and-mitigation plan. The offsite, cumulative effects of many wetland fills within an estuary on basinwide tidal circulation and water levels could be controlled by limiting the siting, uses, and overall amount of landfills. Through this approach, appropriate resource-based constraints to development projects can be identified based on an inventory of physical, biological, esthetic, social, and economic resources. Objectives of the plan are linked consistently with all project proposals, and the costs are shared equitably.

Management plans are initiated generally by groups that have responsibility for local planning and development. To help ensure that the plan will be implemented, the sponsoring group may seek the participation of the Corps and other agencies with regulatory responsibilities. Management planning efforts can be particularly useful for specific areas where pressures for development are intense, there are constraints to development, and inconsistent policies and plans for an area make decisionmaking especially difficult.

Management plans can be used to define which areas are to be protected or developed. For example, the Anchorage Wetland Plan classifies areas into four categories: *preservation,* which precludes any development; *conservation,* which allows limited development with mitigation measures; *developable,* which allows complete draining and filling; and *special study,* which requires additional environmental data to determine status. The plan is being implemented through local planning and control mechanisms and includes a provision for Federal consistency with local coastal-management policies. The Corps currently is preparing to issue a general permit to the city for development activities that occur in wetlands covered by the plan (18).

---

[12] *Federal Register,* vol. 45, No. 184, pp. 62, 757.

Management plans also can be used to restrict certain development activities and establish standards for other types of development. For example, the East Everglades Management Plan prohibits road construction in permanent wetlands, allows agricultural use in some drier areas (particularly those that were disturbed previously), restricts the density of residential development, and defines BMP for three basic management areas. To implement the law, the local government must develop some new mechanisms, including a site-alteration overlay ordinance and a system of transferable development rights; establish new zoning districts; and continue to regulate obstructions to surface water flows under an existing ordinance. State government also has the responsibility of continuing to regulate dredge and fill in the area to the extent authorized under State law and of revising water-quality standards for the area.

Continued regulation of section 404 by the Corps is also an important element in the implementation of the plan, particularly in cases of violations. Corps jurisdiction is broader than the State's, and the Corps has acted more quickly than the county in enforcement actions (9).

Management plans also have been used to resolve the conflicts and inconsistencies between the policies of the numerous agencies with jurisdiction in an area. For example, an objective of the Grays Harbor (Washington) Estuary Management Plan is to set guidelines that offer some assurance that activities permitted by the plan would have general concurrence from all the agencies involved. This planning process is described in detail below.

The Grays Harbor Estuary Planning Task Force was formed in 1975 with representatives from all the agencies responsible for plans and regulations in the area. In 1976, funds were acquired from the Office of Coastal Zone Management (OCZM) for development of the plan, which began with the development of a comprehensive data base delineating the physical and biological resources, ownership, land use, comprehensive plan designations, areas of conflict, and other data. Development of the actual plan occurred during a series of workshops in which the task force determined planning areas, established specific management units, and developed policies to direct development activities in the estuary. The draft plan underwent extensive review, and a final plan recently has been completed.

The Grays Harbor Regional Planning Commission is the lead agency for the plan but has no authority to adopt or enforce the plan. Instead, the plan is recognized as a recommendation from the task force to the numerous agencies involved in the planning process and in development activities in the estuary. At present, an environmental impact statement (EIS) on the plan is being prepared by OCZM.

Each of the agencies involved has been asked also to prepare a memorandum of understanding (MOU) to explain how it perceives the plan, and how it will be used. To date, none of the MOU's have been completed and probably will not be until the EIS is finished. Unofficially, several agencies have indicated that the plan probably will not be considered binding; however, it will be given serious consideration in evaluation of local concerns and the public interest. The Fish and Wildlife Service (FWS) notes that it supports the plan; it has accepted some major environmental losses in exchange for long-term protection of other portions of the estuary. FWS also observes that the plan does not make decisions but will serve as a guideline and should streamline permit review. The Corps also generally supports the plan. The Corps has been asked to give serious consideration to issuing general permits for some activities in the area; in particular, the disposal of dredge or fill material in unvegetated and vegetated intertidal areas designated in the plan for industrial development. To date, no decision has been made on these general permits.

A major issue in the plan is the predesignation of dredged-material disposal sites within the estuary. The Regional Planning Commission and the Port of Grays Harbor have expressed a strong desire for predesignation by EPA; to date, EPA has not made a decision on this issue. Since some of the areas are vegetated and unvegetated wetlands of significant environmental value, EPA has expressed some concern about whether such a predesignation is legal.

State and local concerns about Federal involvement in the plan also have been expressed in another manner. The plan is viewed as an attempt to create a regional plan for shoreline management that will provide consistency and predictability for both development and conservation interests. Through the planning process, least damaging alternatives and compromise solutions were investigated and pursued.

Greater legal commitment of different Federal agencies to the results of any planning efforts of this sort are very much needed. If the Federal agencies cannot commit to the final components of the plan, then case-by-case permit evaluation will replace long-term planning. Not only will predictability and shortened permit processes be precluded, but other local jurisdictions will be discouraged from pursuing comprehensive shoreline planning, an outcome perceived to thwart the goals of OCZM.

In spite of the concerns described above, the plan is considered by many to have been a successful exercise. Representatives from most of the jurisdictions involved felt it was a good idea and have committed time and effort for almost 6 years. The port often has been able to maintain momentum when other agencies lost enthusiasm or became mired in the process. Furthermore, many areas of "predictability" have been identified. Development interests can learn which are controversial locations and which are acceptable. At least some regulatory agency personnel already are using the plan to assist them in making decisions, even if they have not firmly acknowledged its authority (45).

# CHAPTER 6 REFERENCES

1. Allen, K. R. and Hardy, J. W., "Impacts of Navigational Dredging on Fish and Wildlife: A Literature Review," U.S. Fish and Wildlife Service Biological Services Prog., FWS/OBS-80/07, 1980.
2. Banta, J. and Nauman, J., "Mitigation in Dredge and Fill Permits," *Coastal Zone '78,* vol. II, Symposium on Technical, Environmental, Socioeconomic and Regulatory Aspects of Coastal Zone Management, San Francisco, American Society of Civil Engineers, New York, N.Y., 1978, pp. 1316-1332.
3. Barclay, J. S., "The Effects of Channelization on Riparian Vegetation and Wildlife in South Central Oklahoma," *Strategies for Protection and Management of Floodplain Wetlands and Other Riparian Ecosystems,* proceedings of the symposium, Dec. 11-13, 1978, Callaway Gardens, Ga., U.S. Forest Service, GTR-WO-12, 1978.
4. Benforado, J., "Ecological Considerations in Wetland Treatment of Wastewater," *Selected Proceedings of the Midwest Conference on Wetland Values and Management,* B. Richardson (ed.), St. Paul, Minn., 1981, pp. 307-323.
5. Blumm, M. C., "The Clean Water Act's Section 404 Permit Program Enters its Adolescence: An Institutional and Programmatic Perspective," *Ecology Law Quarterly,* vol. 8, 1980, pp. 409-464.
6. Boss, T. E., personal communication, 1982.
7. Cairns, J., Jr., Bunson, M. M., Johnson, R. L., Parker, W. B., Turner, R. E., and Winger, P. V., "Impacts Associated with Southeastern Bottomland Hardwood Forest Ecosystems," *Wetlands of Bottomland Hardwood Forests,* J. R. Clark and J. Benforado (eds.), Proceedings for Workshop on Bottomland Hardwood Forest Wetlands of the Southeastern United States, June 1-5, 1980 (Lake Lanier, Ga.: Elsevier Scientific Publishing Co., 1981.)
8. Canter, L. W., Klehr, E. H., Laguros, J. W., Streebin, L. E., Miller, G. D., and Cornell, D. R., "An Assessment of Problems Associated with Evaluating the Physical, Chemical and Biological Impacts of Discharging Fill Material," Technical Report No. D-77-29, U.S. Army Corps of Engineers, Washington, D.C., 1977.
9. Center for Governmental Responsibility, "Wetlands Loss in South Florida and the Implementation of Section 404 of the Clean Water Act," University of Florida, College of Law, contract study for OTA, September 1982, pp. 80-81.
10. Center for Wetland Resources, "Wetland Trends and Factors Influencing Wetland Use in the Area Influenced by the Lower Mississippi River: A Case Study," Louisiana State University, contract study for OTA, September 1982, p. I-51.

11. Clewell, A. F., "Vegetational Restoration Techniques on Reclaimed Phosphate Strip Mines in Florida," *Journal of Wetland Scientists,* September 1981, pp. 158-159
12. Comptroller General of the United States, "Report to the Congress of the United States, Developing Alaska's Energy Resources: Actions Needed to Stimulate Research and Improve Wetlands Permit Processing," General Accounting Office, GAO/EMD-82-44, 1982.
13. Craig, N. J., Turner, R. E., and Day, J. W., Jr., "Wetland Losses and Their Consequence in Coastal Louisiana," *J. Geomorph.*, M. F. Suppl.—Bd 34, 1980, pp. 225,241.
14. Darnell, R. M., Pequenat, W., James, B. M., Benson, F. J., and Defenbaugh, R. A., "Impacts of Construction Activities in Wetlands of the United States," U.S. Environmental Protection Agency, EPA 600/3-76-045, 1976.
15. Deegan, L. A., Kennedy, H. M., and Costanza, R., "Factors Contributing to Marshland Loss in Louisiana's Coastal Zone," presented at the 3d International Conference on State-of-the-Art in Ecological Modeling, Colorado State University, Fort Collins, Colo., 1982.
16. Demgen, F. D. and Nute, W. J., "Wetlands Creation Using Secondary Treated Wastewater," Mt. View Sanitary District, Calif., AWWA Research Foundation, Washington, D.C., 1979.
17. ESA/Madrone, "Wetlands Policy Assessment: California Case Study," contract study for OTA, September 1982, p. 265.
18. ESA/Madrone, "Wetlands Use and Regulation: Alaska Case Study," contract study for OTA, January 1983.
19. Fredrickson, L. H., "Floral and Faunal Changes in Lowland Hardwood Forests in Missouri Resulting From Channelization, Drainage and Impoundment," U.S. Fish and Wildlife Service," Eastern Energy and Land Use Team, FWS/OBS-78/91, 1979.
20. Garbisch, E. W., Woller, P. B., and McCallum, R. J., "Salt Marsh Establishment and Development," Environmental Concern, Inc., St. Michaels, Md., Coastal Engineering Research Center, Fort Belvoir, Va., 1975.
21. Giese, G. S. and Mello, M. J., "Effects of Inlet Dredging on a Small Estuary," In: *Proceedings of the Third Annual Meeting Society of Wetland Scientists,* Wrightsville Beach, N.C., 1982.
22. Great Plains Office of Policy Studies, "Wetland Trends and Protection Programs in Nebraska," University of Nebraska, contract study for OTA, September 1982, p. 25.
23. Guntenspergen, G. and Stearns, F., "Ecological Limitations on Wetland Use for Wastewater Treatment, *Selected Proceedings of the Midwest Conference on Wetland Values and Management, June 17-19, 1981,* B. Richardson (ed.), St. Paul, Minn., 1981.
24. Herrgesell, P. L., Kohlhorst, D. W., Miller, L. W., and Stevens, D. E., "Effects of Freshwater Flow on Fishery Resources in the Sacramento-San Joaquin Estuary," *Proceedings of the National Symposium on Freshwater Inflow to Estuaries,* R. D. Cross and D. L. Williams (eds.), U.S. Fish and Wildlife Service National Coastal Ecosystems Team, FEW/OBS-81-04; NTIS No. PB 82-131434, 1981.
25. Hershman, M. and Ruotsala, A., "Implementing Environmental Mitigation Policies, *Coastal Zone '78,* vol. II, Symposium on Technical, Environmental, Socioeconomic and Regulatory Aspects of Coastal Zone Management. San Francisco, American Society of Civil Engineers, New York, N.Y., 1978, p. 1333.
26. Hicks, D. B., Cavendar, T. R., Carroll, B. J., Raschke, R. L., and Murphy, P. M., "Finger-fill Canal Studies, Florida and North Carolina," U.S. Environmental Protection Agency, Athens, Ga., EPA 904/9-76-017; NTIS PB-265-645, 1975.
27. Hirsh, N. P., Di Salvo, L. H., and Peddicord, R., "Effects of Dredging and Disposal on Aquatic Organisms," U.S. Army Corps of Engineers, Technical Report No. DS-78-5, 1978.
28. JACA Corp., "A Case Study of New Jersey Wetlands Trends and Factors Influencing Wetlands Use," contract study for OTA, September 1982, pp. 1-12.
29. Lahti, T., "Restoration of a Small Suburban Southern Wisconsin Wetlands," *Wetlands: Ecology, Values and Impacts,* Proceedings of the Waubesa Conference on Wetlands, Madison, Wis., 1977.
30. Longley, W. M., Jackson, R., and Snyder, B., "Managing Oil and Gas Activities in Coastal Environments," U.S. Fish and Wildlife Service, National Coastal Ecosystems Team, FWS/OBS-78/54, 1978.
31. Maki, T. E., Weber, A. J., Hazel, D. W., Hunter, S. C., Hyberg, B. T., Flinchum, D. M., Lollis, J. P., Rognstad, J. B., and Gregory, J. D., "Effects of Stream Alteration on Bottomland and Swamp Forest Ecosystems," University of North Carolina, Water Resources Research Institute, Raleigh, N.C., UNC-WR11 80-147, 1980.
32. Michigan Department of Natural Resources, "Manual for Wetland Evaluation Techniques," op-

erational draft, Division of Land Resource Programs, 1980.

33. Mitchell, D., "Restoration of a Salt Marsh on the Salmon River Estuary,"Estuarine Research Federation Conference, Salishan, Ore., 1981.
34. Myhrum, C. B., "Federal Protection of Wetlands through Legal Process," Boston College Environmental Affairs Law Review, vol. 7, No. 4, 1979, pp. 567-628.
35. National Waterfowl Management Plan for the United States, Cooperators: U.S. Fish and Wildlife Service, Pacific Flyway Council, Central Flyway Council, Mississippi Flyway Council, Atlantic Flyway Council, 1982.
36. National Wetlands Newsletter, "California Wetlands; California Wetlands Guidelines; California Tidelands: Public or Private?; California Wetlands Banking; California's Coastal Conservancy," vol. 3, No. 3, 1981, pp. 5-11.
37. Nelson, R. W., Shea, G. B., and Logan, W. J., "Ecological Assessment and Reduction of Impacts from Inland Dredge and Fill Operations," U.S. Fish and Wildlife Service, Eastern Energy and Land Use Team, Kearneysville, W.Va., FWS/OBS-82/19, 1982.
38. Nelson, R. W., Logan, W. J., and Weller, E. C., Playa Wetlands and Wildlife of the Southern Great Plains: A Characterization of Habitat, U.S. Fish and Wildlife Service, Western Energy and Land Use Team, in press.
39. Newcombe, C. L., Morris, J. H., Knutson, P. L., and Gorbics, C. S., "Bank Erosion Control with Vegetation; San Francisco Bay, California," U.S. Army Coastal Engineering Research Center, Fort Belvoir, Va., 1979.
40. Parish, G. E. and Morgan, J. M., "History, Practice and Emerging Problems of Wetlands Regulation: Reconsidering Section 404 of the Clean Water Act," *Land and Water Review,* vol. 27, No. 1, 1982, pp. 43-84.
41. Parker, J. C., Holcomb, H. W., Jr., Klussman, W. G., and McNeill, J. C. IV, "Distribution of Aquatic Macro-Fauna in a Marsh in West Galveston Bay, Texas, and Possible Effects Thereon Resulting from Impoundments for Shrimp Culture," Texas A. & M. University, Sea Grant Prog. Rep. No. TAMU-SG-71-208; NTIS-PB 199-196, 1971.
42. Race, M. S. and Christie, D. R., "Coastal Zone Development: Mitigation, Marsh Creation, and Decision-Making," *Environmental Management Journal,* vol. 6, No. 4, 1982, pp. 317-328.
43. School of Forestry and Environmental Studies, "Wetland Trends and Policies in North and South Carolina," Duke University, contract study for OTA, August 1982, p. 99.
44. Schuldiner, P. W., Cope, D. F., and Newton, R. B., "Ecological Effects of Highway Fills on Wetlands—User's Manual," National Cooperative Highway Research Program Reports 218A and 218B, Transportation Research Board, National Research Council, Washington, D. C., TRB/NCHRP/REP-218A and 218B, NTIS No. PB 80-142094, 1979.
45. Shapiro and Associates, Inc., "An Analysis of Wetlands Regulation and the Corps of Engineers Section 404 Program in Western Washington," contract study for OTA, September 1982.
46. Shea, G. B., "Rain River Preserve Management Plan," The Nature Conservancy, Portland, Ore., 1977.
47. Shea, G. B. and Boss, T. E., "Rain River Preserve Management Studies, Final Annual Report," Western Eco-Systems Technology, Bothell, Wash., 1981.
48. Shea, G. B., "Hydrologic and Biological Studies for Restoration of the Storkan Marsh, Oak Bay, Washington," Western Eco-Systems Technology, Bothell, Wash., 1981.
49. Shea, G. B., "Hydrologic and Biological Studies of Finel Swamp, Maryland," Western Eco-Systems Technology, Laurel, Md., 1981.
50. Teas, H. J., "Ecology and Restoration of Mangrove Shorelines in Florida," *Environmental Conservation,* vol. 4, No. 1, 1977, pp. 51-58.
51. Ternyik, W. E., "Salt Marsh Creation in the Pacific Northwest: Criteria, Planting Techniques, and Costs," Wave Beach Grass Nursery, Florence, Ore., Rehabilitation and Creation of Selected Coastal Habitats: Proceedings of a Workshop, Sapelo Island, Ga., 1976.
52. Tolman, A. J., "Florida's Water Resources Restoration Program," Florida State Department of Environmental Regulation, Tallahassee, Fla. Lake Restoration, report No. EPA 440/5-79-001, 1979, pp. 39-40.
53. Turner, R. E., Costanza, R., and Scaife, W., "Canals and Wetland Erosion Rates in Coastal Louisiana," unpublished report, Center for Wetlands Resources, Louisiana State University, Baton Rouge, La., 1982.
54. U.S. Army Corps of Engineers, Institute of Water Resources, "Regulatory Impact Analysis," unpublished report, Fort Belvoir, Va., 1982.
55. Virginia Institute of Marine Science, Gloucester Point (VIMS), "Habitat Development Field Investigations, Windmill Point Marsh Development Site, James River, Virginia," app. D, Environmental Impacts of Marsh Development with Dredged Material, Botany, Soils, Aquatic Biology, and Wildlife, 1978.

56. Water Resources Research Center, "Regional Assessment of Wetlands Regulation Programs in New England," University of Massachusetts, contract study for OTA, September 1982.
57. Webb, J. W. and Dodd, J. D., "Shoreline Plant Establishment and Use of a Wave-Stilling Device," paper No. 78-1, U.S. Army Coastal Engineering Research Center, Fort Belvoir, Va., 1978.
58. Wigham, D. R. and Simpson, R. L., "Sewage Spray Irrigation in a Delaware River Freshwater Tidal Marsh," *Freshwater Wetlands and Sewage Effluent Disposal*, Proceedings of National Symposium May 10-11, 1976, University of Michigan, Ann Arbor, Mich., NSF/RA-760251; NTIS No. PB 259 305, 1976.
59. Wile, I., Miller, G., and Black, S., "Design and Use of Artificial Wetlands," unpublished paper, 1981.
60. Woodhouse, W. W., "Building Salt Marshes Along the Coasts of the Continental United States," U.S. Army Coastal Engineering Research Center, Fort Belvoir, Va., 1979.

# Chapter 7

# The Effects of the 404 Program

Photo credit: OTA staff, William Barnard

# Contents

Page

**Chapter Summary** . . . . . . . . . . **141**

**Effects on Wetlands** . . . . . . . . . . **141**
Program Effects Not Reflected in Permit Data . . . . . . . . . . 142
Program Effects Reflected in Program Data . . . . . . . . . . 143

**Effects on Development Activities** . . . . . . . . . . **145**
Benefits of the 404 Program to Regulated Sectors . . . . . . . . . . 146
General Objections to the Program by Regulated Sectors . . . . . . . . . . 147
Specific Impacts of the 404 Program . . . . . . . . . . 152

**Processing Costs** . . . . . . . . . . **154**

**Modification Costs** . . . . . . . . . . **155**

**Delay Costs** . . . . . . . . . . **156**
Percentage of Permits Delayed . . . . . . . . . . 156
Length of Delays . . . . . . . . . . 157
Sources of Delays . . . . . . . . . . 157

**Opportunity Costs** . . . . . . . . . . **159**

**Distribution of Costs** . . . . . . . . . . **160**

**Chapter 7 Technical Notes** . . . . . . . . . . **161**

## TABLES

*Table No.* *Page*
23. Corps of Engineers' Wetland Acreage Survey, 1980 to 1981 . . . . . . . . . . 145
24. Estimated Effects of Technology Transfer on Financial Costs . . . . . . . . . . 147

## Chapter 7

# The Effects of the 404 Program

## CHAPTER SUMMARY

According to U.S. Army Corps of Engineers estimates for 1980-81, Corps districts (excluding Alaska) processed permits for projects that, if completed as requested, would have resulted in direct and indirect conversion of approximately 100,000 acres of wetlands per year. The Corp's authorized projects that, if completed in accordance with the conditions of the permits would involve the conversion of approximately 50,000 acres of wetland or about half the acreage applied for. National Marine Fisheries Service (NMFS) data for the coastal wetlands (in the lower 48 States) indicate that the 404 program, in combination with State regulatory programs, reduced the conversion of coastal wetlands by 70 to 85 percent in 1981. Thus, several thousand acres of coastal (saltwater) wetlands are probably being converted to other uses each year. Moreover, each year about 5,000 acres of vegetated wetlands either are created or restored for mitigation purposes as a direct result of the "conditioning" of 404 permits.

There are probably numerous cases where regulatory costs or delays to developers have been substantial—in some cases, millions of dollars. But little verifiable data are available to document the overall impacts of 404 on development activities, especially as they relate to other costs imposed by other policies and programs (such as sec. 10, the National Environmental Policy Act (NEPA), State programs; and local ordinances) and general economic conditions. Information collected by this study suggests that 404, for the most part, minimizes or compensates for impacts rather than prevents development.

All permit applicants bear at least some 404-related costs resulting from permit denials, modifications of projects, permit processing, and/or processing delays. Of approximately 11,000 project applications per year, slightly less than 3 percent are denied; about one-third are modified significantly to reduce wetland impacts; and about 14 percent are withdrawn by applicants. About half are approved without significant modifications. From 1977 to 1981, the average processing time for non-EIS (environmental impact statement) permits was about 130 days; in 1983, the average processing time was about 70 days. Less than 1 percent of all projects permitted by 404 require an EIS, which may take several years to complete. Delays in processing permit applications for the relatively few large-scale projects that represent the bulk of the economic value of all proposed development activities probably account for a substantial portion of the total costs to industry associated with the 404 program.

## EFFECTS ON WETLANDS

In many areas of the country, the 404 program is the only Government program controlling the use of wetland resources. This chapter discusses the *effects* of the 404 program on wetlands; however, it does not evaluate the *effectiveness* of the program. Analysis of effectiveness requires judgments about how the program should optimally or realistically perform to reach both specified goals and measurements of the actual performance against the ideal. This chapter presents evidence of how the 404 program actually has affected wetlands.

Theoretically, the effect of the 404 program on wetlands use can be quantified from permit data by tallying the acreage of wetlands that are not converted as a direct result of the permit evaluation process, or the acreage on which the impacts of development have been lessened, and the acreage of wetlands that have been created or restored as a result of the program. In practice, it is very difficult to present an accurate picture of the effects of the program. Very little quantitative information has been compiled detailing what the program has accomplished.

Although many sources were consulted, the following are the only available sources of hard data on the effects of the program nationwide:

- The Corps' Regulatory Functions Branch summaries, covering basic information such as number of permit applications, denials, and withdrawals.
- The Corps' Institute for Water Resources (IWR) report, *Impact Analysis of the Corps Regulatory Program*. The major source of data for the IWR report was a "regulatory impact assessment" (RIA) questionnaire, sent to all Corps districts by the Regulatory Functions Branch in 1981. This report only appeared in draft form and has not been released officially (1).
- OTA survey of Corps districts. OTA sent all Corps offices a questionnaire designed to supplement information available from other sources. Of 38 offices, 37, including all 36 Corps districts, responded. (The Honolulu office did not respond to the survey.)

These sources were supplemented by other materials, such as an OTA survey of the 50 States, case studies of 21 States conducted by contractors for OTA, data on NMFS Southeast region permit recommendations, and interviews conducted by OTA staff.

While adequate data are available on such basic indices as the number of permit applications and issuances, information is far more sketchy concerning permit modifications, mitigation, and other things necessary to assess the impact of the program on wetlands. Few districts compile the permit information necessary for an evaluation of the program. Usually, Corps personnel have been forced to make unverifiable estimates when asked to provide quantitative data on the program. Composites of such approximations probably convey an accurate overall picture but make the accuracy of resulting statistics open to question. In the absence of firm data, estimates from different sources must be weighed against one another.

Interpretation of data from the above materials is complicated further by several factors. First, Corps districts have great independence and flexibility in how they interpret the requirements of the 404 program and often differ considerably in the types of wetlands and development activities encompassed within their boundaries. Many of the conclusions of most studies of 404-program effects are based on information from a limited sample of districts.

Second, it is extremely difficult to separate the effects of the 404 program from the effects of other influences on the use of wetlands. It is likely that general economic conditions, such as interest rates, and conditions specific to particular development activities or areas have much greater effects upon wetland development than do governmental regulations.

Third, while reduction of wetland loss rates cannot be *exclusively* attributed to the 404 program, it is clear that in the great majority of States, the program plays a crucial role in regulating the use of many wetlands. When States were asked by OTA to evaluate the relative importance of the 404 program in comparison with State programs, 10 States asserted that the 404 program is redundant and relatively unimportant in management of both coastal and inland wetland areas and that their State programs play the dominant role. However, separation of the effects of the 404 program from those of State programs is possible only where State programs do not exist or do not cover activities or areas dealt with by the 404 program.

## Program Effects Not Reflected in Permit Data

The 404 program has been successful in reducing damage to wetlands through actions not reflected in permit data and which are difficult to quantify. The greater the number of projects submitted to the 404 process and the more environmentally damaging those projects are, the more permit modifications and denials are likely to be required by the Corps. Measures taken by the Corps to improve the program have reduced the number of permits submitted and made those that are reviewed less environmentally damaging, thus masking the quantifiable effects of the 404 program.

The *expanded use of general permits* has reduced the number of permit applications by an estimated 90,000 cases annually.[1] While these permits may decrease control over the use of wetlands (as is discussed elsewhere in this report), other general permits benefit wetland protection when best management practices (BMPs) are required as part of permit conditions.

*Preapplication consultations*[*] also lessen project impacts; they may result in applicants changing a planned activity so that it requires less wetland acreage or no longer occurs on a wetland—i.e., either transferring the activity to an upland area or canceling it. Better management practices may be suggested that limit the impacts on those wetlands that are used. The activity also may be altered so that it falls under a general permit, thereby presumably having an acceptable impact on the wetlands of a particular region (2).

Consultations also may result in savings to applicants. Permit application requirements can be clarified, reducing the chance that applications would have to be resubmitted, for example, to make up for gaps in information. On the other hand, Corps suggestions may entail additional costs to the applicant or reduce the benefits expected from a project.

According to district estimates in the OTA survey, a range of 5 to 90 percent (with a mean of 30 percent) of applicants consult with the Corps prior to submitting an application. A much higher percentage of parties planning *large* projects consult with the Corps. Several districts reported that nearly all applications for major projects entailed preapplication consultations, and most industry associations and firms responding to another OTA survey said that they routinely set up appointments with the Corps to discuss planned activities, particularly if the activities are large scale.

Results of consultations are more difficult to summarize. Most consultations take place at an early stage in project planning, before applicants have detailed plans that specify the acreage of wetlands potentially involved. Still, most districts believe that such consultations have had significant benefits for wetland protection. Because of the lack of data, very few estimates were made of reductions of amounts of dredged and fill material or of alterations of wetland acreage that were achieved by consultations. Instead, more qualitative estimates were given, sometimes in terms of the percentage of permits that were modified in the course of consultations. These estimates can be categorized as follows: 9 districts said they could not estimate the effects of consultations; 4 indicated that results were insignificant (e.g., "very few" projects were modified); 10 indicated that results were good (e.g., consultations had a "good" effect; 10 percent of applications were modified); and, 14 said results were very good (e.g., consultation results were "substantial;" 50 percent of applications were modified).

A last form of program success not reflected in permit data stems from the increased public knowledge that has arisen about wetland benefits and about regulations that require the developer to apply for a permit to develop many wetlands. This awareness has meant that an unknown number of projects have been initiated than might otherwise have been, that many projects affect wetlands less than they otherwise might have, and that fewer permits, therefore, are denied or modified by the Corps.

## Program Effects Reflected in Program Data

### Reduction of Wetland Loss

The major effects of the 404 program are the reduction of wetland conversions through permit denials, modification of permits to reduce the number of wetland acres affected, and conditions attached to permits that lessen the impact of activities on the wetlands that are used.

Only a small number of section 404 and section 10/404 permit applications are denied; (291 out of 10,718 applications received in fiscal year 1981, about 2.7 percent). It should be noted that districts vary greatly in the percentage of permits denied. Twelve reported on the OTA survey that they deny 1 percent or less of permit applications, while ten deny more than 5 percent. About 14 percent of permit applicants (1,545) withdrew their applications before the Corps rendered a decision.

---

[1] Pacific Legal Foundation, "A Report to the Presidential Task Force on Regulatory Relief," Mar. 18, 1982, p. 28.

[*] This term refers to advice given by Federal personnel to those inquiring about activities that might require a 404 permit.

A much greater number of permits are modified in the course of the permit process. The IWR report estimated that one-third are "substantially modified."[2] Another source estimated that more than half have conditions attached.[3] Information collected by OTA supports these estimates. OTA asked districts to estimate the percentage of permits requiring a 404 review that were substantially modified. Several districts separated their estimates into permits that were modified substantially and those that received more minor modifications, saying that almost all permits were conditioned or modified to some degree. Two districts said they did not require substantial modifications to any permit in the period considered. One of these, however, denied a large percentage of 404 applications. Two others did not make percentage estimates, saying that many or most permits were modified substantially. The estimates of the remaining districts varied from 3 to 95 percent. The majority of districts gave estimates ranging from 20 to 40 percent, and the mean of all districts was 31 percent.

The effects of the 404 and State regulatory programs on potential wetland conversions can be estimated using two main sources of data: NMFS Southeast region figures and results of a Corps survey. The NMFS Southeast region, has jurisdiction over coastal areas from Texas to North Carolina including about 90 percent of all coastal (saltwater) wetlands in the lower 48 States (according to FWS trend data). The Southeast region made recommendations that, if implemented, would have had the following effects: During fiscal year 1981 NMFS reviewed projects that would have resulted in the conversion of about 14,000 acres of vegetated wetlands. NMFS recommendations, which were accepted in about 98 percent of the cases, could have resulted in the potential preservation of about 85 percent of these wetlands proposed for conversion. Since about 20 percent of the projects were in violation of permit conditions, the actual acreage of wetlands saved from conversion by Federal and State permitting programs in coastal areas probably ranges from 70 to 85 percent.[4] Thus, several thousand acres of coastal (saltwater) wetlands are probably being converted to other uses each year.

According to recent estimates compiled by the Corps for 1980 and 1981 (table 23), its districts (excluding Alaska) processed permits for projects that, if completed as requested, would have resulted in direct and indirect conversion of approximately 100,000 wetland acres per year. However, the Corps authorized projects that involved converting approximately 50,000 acres of wetlands. In other words, the 404 program, in combination with State programs, was responsible for preserving about 50,000 acres of wetlands if there is compliance with all permit conditions. This is a 50-percent reduction in potential conversions from modifications, withdrawals, and denials of 404 permits. Actual compliance with permit conditions in NMFS Southeast region is about 70 percent. The acreage saved by the 404 program is probably less than 50,000; how much less is uncertain. In addition, some conversions may have been deterred simply by the existence of the regulatory programs; other conversions may have been prevented through preapplication consultations with the Corps.

### Creation of New Wetlands/Restoration of Degraded Wetlands

New wetlands are created and degraded wetlands are restored or enhanced as a result of the 404 program. In some cases, 404 permit applicants create or restore wetland acreage as compensation or mitigation for acreage degraded or converted by a permitted activity. In other cases, persons who have altered wetlands under the scope of the Corps' regulatory program without a permit, or who have violated permit conditions, have been required to miti-

---

[2] Institute for Water Resources, U.S. Army Corps of Engineers, "Impact Analysis of the Corps Regulatory Program," unpublished report, November 1982, p. 62.

[3] Jeffrey A. Zinn and Claudia Copeland, "Wetlands Management," Congressional Research Service, July 1982, p. 125.

[4] Figures from W. N. Lindall and G. W. Thayer, "Quantification of National Marine Fisheries Device Habitat Conservation Efforts in the S.E. Region of the United States," vol. 44, No. 12, 1982 pp. 18-22. During a conversation in June 1983, Lindall estimated that 75 to 80 percent of the acreage in columns 2, 3, and 4, table 1 from this paper were vegetated wetland; 90 percent of acreage in columns 8, 9, and 10 were vegetated.

**Table 23.—Corps of Engineers' Wetland Acreage Survey, 1980 to 1981**

| | Total acreages (in thousands) | |
|---|---|---|
| | Exclusive of Alaska and Hawaii | Including Alaska |
| 1. Total acreage of "technical" wetlands[a] | 64,100 | 287,100 |
| 2. Total acreage of wetlands regulated under individual permit | 46,700 | 209,700 |
| 3. Wetland fill requested, past 2 years: | | |
| Direct (smothered) | 56.0 | 63 |
| Indirect (flooded, drained, etc.) | 124.9 | 124.9 |
| 4. Wetland fill authorized, past 2 years (direct only) | 30.2 | 36.7 |
| 5. Wetlands created for mitigation, past 2 years | 9.6 | 9.6 |
| 6. Wetland dredging requested, past 2 years: | | |
| Direct (dredged) | 13.4 | 14.4 |
| Indirect (sidebank, slumping, etc.) | 15.0 | 15.0 |
| 7. Wetland dredging authorized past 2 years (direct only) | 3.3 | 4.3 |

[a] Total wetland acreage estimates based on the Corps' "technical" definition of wetlands. They are therefore less than the average of wetlands estimated from the FWS National Wetland Trends Study.

SOURCE: Army Corps of Engineers.

gate impacts through wetland creation or restoration.

IWR reported an estimate that "less than 5,000 acres" of wetlands are created annually,[5] presumably as a result of the 404 program. While several individual cases of restoration were listed, IWR did not estimate the total acreage of wetlands restored annually.

The NMFS Southeast region office recommended that 2,493 wetland acres be created and 1,469 be "generated/compensated" in that area from July 1981 to June 1982.[6]

Based on the OTA survey, 25 Corps districts estimated that 1,200 to 1,700 acres were created and 2,300 to 2,800 acres were restored annually (3). These amounts do not include two cases in which Florida phosphate mines have or will "re-create" about 3,500 acres of wetlands "to obtain the required State and Federal permits" or to satisfy State requirements. A Corps survey of districts and Corps responses to OTA's questionnaire indicated that about 5,000 acres of wetlands are created annually.

---

[5] Institute for Water Resources, op. cit., p. 114.

[6] Lindall and Thayer, op. cit.

# EFFECTS ON DEVELOPMENT ACTIVITIES

Although many development activities benefit from wetland protection, the 404 program also imposes costs on development from the processing, modifications, and delays entailed in the 404 permitting process. Aside from financial costs, more general objections to the program voiced by such parties as industry trade associations include questions about the need for the program to protect wetlands, congressional intent regarding wetlands and the 404 program, the value of wetlands versus the value of their development, and possible inefficient or inequitable program administration.

Some firms state that they have borne major 404-related costs, in some cases millions of dollars, and it is evident that all firms that go through the permitting process bear at least some costs. However, although many individual firms have abundant material on their own experiences, very little data are available that aggregate individual experiences into industrywide estimates. Very few trade associations have collected detailed statistics from their membership.

The desire to reduce costs brought by the 404 program to permit applicants has been a major factor in many or most efforts to change the 404 program through legislative and regulatory revision. Many industry associations and firms have voiced their unhappiness with the current program. In particular, the program is said to be unnecessary, or at least overly restrictive and cumbersome, and to cause large financial losses to permit applicants through modifications and delays to projects imposed by Federal agencies. The Office of Management and Budget (OMB) stated that its suggested reforms to the program could save $1 billion annually.[7] On the other hand, defenders of the program argue that it is not costly, either in absolute terms or in comparison with the benefits it brings, and that many sectors of society, including several major industries, are aided by the program.[8]

This section discusses perceptions of the 404 program held by regulated sectors and the costs and benefits to permit applicants of this program. There is a paucity of data on the costs and benefits of the 404 program and of other Federal and State wetland programs to regulated sectors. OTA examined previously published estimates, surveyed industry associations, and collected data from other sources (4). OTA also surveyed States about whether they had made estimates of the costs to permit applicants of State or Federal wetland permitting programs. No State had collected information on such costs. Massachusetts officials estimated that, assuming that the average bank carrying cost "to hold option on raw land, assuming an average 20-acre subdivision, single-family homes," of a project is $2,000/month, and the average decision time for State permitting is 2.5 months, the average cost to the project would be $5,000, plus consulting and legal fees. Several States gave data on permit fees charged to applicants. Not including EIS costs, fees ranged from zero (e.g., Maryland) to 0.5 percent of construction costs with a minimum of $100 (New Jersey). Most fees ranged from $15 to $75. One industry association, the Fertilizer Institute (FI), reported that permit application fees in Florida now are $100 for the short form, for more minor projects, and $1,000 for the standard form, for relatively major projects.

## *Benefits of the 404 Program to Regulated Sectors*

### Environmental Benefits Captured by Industry

Many types of firms experience both costs and benefits from the 404 program. For example, members of the housing-construction industry believe that 404 program costs severely impact the industry's operations; at the same time, land values adjacent to wetlands protected by section 404 often increase, benefiting some builders as well as existing homeowners.

The RIA questionnaire asked Corps districts to rate the impacts of the regulatory program (including sec. 10) on 14 sectors (5). Districts unanimously believed that the fishing industry benefited from the program and were near unanimous that the general public benefited. More than 80 percent thought that government and public service and land values adjacent to permit areas benefited, and more than 60 percent saw benefits accruing to the agricultural industry and to private individuals (6).

### Technology Transfer

Advice given by Federal personnel to permit applicants prior to submission of an application, and in the course of permit review after submission of an application, may result in savings to applicants as well as protection of wetlands. Small projects and private individuals, in particular, may benefit from information about current engineering and management practices that can make projects more efficient and less costly. Called "technology transfer" by the Corps, these practices produce such benefits as avoidance of erosion losses and stabilization costs when natural vegetation and drainage features are preserved and utilized.

Based on a telephone survey of 12 districts, the IWR report estimated that for 15 to 30 percent of issued permits, the projects approved are more efficient or less costly to develop than those originally proposed. Average savings were estimated to be 15 percent of total project costs. (However, in a table showing calculations, savings were estimated to be 15 percent of "site development costs," which in turn were thought to be 25 percent of the total project cost.) Using an estimated total financial cost of over $217 billion for all projects and an amortization factor of 10 percent for 25 years for the "social value" of projects, IWR estimated total benefits from technology tranfer to range from $135.5 million to $271 million.[9]

---

[7] Office of Management and Budget press release, May 7, 1982.

[8] National Wildlife Federation and 13 other organizations, "Section 404: A Response to the Army-OMB Regulatory Reform Proposals," May 1982.

Many projects undoubtedly experience benefits. However, the IWR estimate appears to be overstated greatly. The methodology used for the IWR report has serious flaws (7), and does not correspond to the responses received by OTA from Corps districts.

The OTA survey of Corps districts asked respondents to estimate the proportion of permitted projects that have benefited from technology transfer, and the average percentage of savings in terms of project development costs. Most districts do not keep any records on technology benefits. As stated by one, "As project costs are seldom, if ever, provided with permit applications, it is impossible to estimate savings in project costs without loss of benefits."* Thus, answers to the survey questions were estimates rather than calculations from data.

As with all aspects of the 404 program, districts vary tremendously in how they perceive technology transfer. Owing to lack of data, 14 districts did not make any estimates of technology transfer benefits. Seven districts said that the program did not result in savings to projects. Five of this latter group thought that costs were increased rather than decreased to applicants. Four districts said that "few" or "very few" projects experienced savings. One district said that "a number" of modifications to projects resulted in "potential savings." Finally, 11 districts gave numerical estimates of technology-tranfer benefits.

Estimates of the percentage of projects gaining savings from technology transfer and the percentage of those savings, in order of magnitude of estimated savings, are shown in table 24.

**Table 24.—Estimated Effects of Technology Transfer on Financial Costs**

| District | Percentage of projects | Percentage of savings |
|---|---|---|
| 1 . . . . . . . . | 1 | No estimate |
| 2 . . . . . . . . | 5 | No estimate |
| 3 . . . . . . . . | 5 | 10 |
| 4 . . . . . . . . | 5 | 20 |
| 5 . . . . . . . . | 5-10 | 5-10 |
| 6 . . . . . . . . | 10 | 5 |
| 7 . . . . . . . . | 10-15 | 5-10 |
| 8 . . . . . . . . | 15-20 | 10-20 |
| 9 . . . . . . . . | 20 | 10 |
| 10 . . . . . . . . | 25 | 20-30 |
| 11 . . . . . . . . | 40-45 | 20-30 |

SOURCE: Data from Corps district responses to OTA's questionnaire.

While the means of these estimates (13 to 15 percent of permitted projects benefiting; 12- to 16-percent savings) are more or less in the range given by IWR, the view of most Corps districts is that technology transfer benefits are infrequent or cannot be documented. As stated by several districts in response to the survey, the goal of permit modifications is not to reduce costs to applicants but to reduce or avoid environmental impacts of projects on wetlands.

OTA also asked industry associations to estimate technology transfer benefits to their members. The associations involved generally have strong objections to aspects of the 404 program and may not be representative of the experience of other industries with respect to such benefits.

Of the eight associations or groups of firms responding specifically to this question, seven said that such benefits do not accrue. One association said that its members benefited from Corps advice on water-related projects (e.g., building of structures in waterways and the design of dams and impoundments). The percentage of projects that were estimated to experience such benefits was less than 5 percent; the amount of savings less than 1 percent of total project costs.*

## General Objections to the Program by Regulated Sectors

The major concern of regulated sectors about the 404 program are the costs suffered as a result of the program processing, delays, modifications, and opportunity costs—and related effects on national interests, such as energy supply. How these costs are evaluated depends not only on their absolute magnitude but also on how the observer evaluates the 404 program itself. A strong supporter of the objectives of the 404 program could find even large costs in all categories acceptable if it could be shown that these goals were met as a result. Conversely, even relatively small costs in a single category could be regarded as unacceptable if the 404 program were judged unnecessary or of low priority. In addition, the evaluation of costs is affected by how the administration of the 404 program is viewed—whether the program is seen as efficiently and equitably implemented or needlessly costly and time consuming to applicants. Before discussing specific quantifiable costs, some of the more important objections to the rationale and administration of the program are summarized.

---

[9] Institute for Water Resources, op. cit., pp. 135-36.

*Response from the Corps' Detroit District.

*Response from the American Mining Congress.

### The Need for the 404 Program to Protect Wetlands

Although most industries agree that at least some wetlands provide important benefits to society,* a number of sources contend that the 404 program is not essential for protecting wetland resources. One argument is that conversion rates were only 0.5 percent per year between the 1950's and 1970's and are probably less now. Since wetlands are not under great threat from the activities regulated by the program, the scope of the 404 program may be reduced without great harm to wetlands. One source, using the U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS) information, stated that annual creation of new wetlands exceeds wetland destruction.[10] Another source, interpreting IWR figures, contended that annual wetland conversion is small relative to the total wetland acreage in the United States—about 300,000 acres per year out of more than 148 million acres regulated by the program, or 0.2 percent. If the 404 program prevents a similar amount of wetland acreage from being converted annually, as claimed by IWR, abolition of the 404 program would result only in approximately doubling this conversion rate, which in the eyes of this source would represent an insignificant amount of wetland converted.[11]

Similar arguments are made with respect to the impacts of development activities in specific areas. For example, according to one estimate, oil company operations on the North Slope of Alaska have resulted in the "disturbance" of approximately 7,300 acres of tundra.[12] Depending on the frame of reference used—whether this acreage is compared with the total tundra acreage of all of Alaska, the North Slope region alone, or just the area within the oilfield where the disturbance is concentrated—this area represents from considerably less than 1 percent to 4.5 percent of tundra. It is argued that the impacts of oil extraction should be considered in relation to the far greater number of acres left undisturbed.

Last, many sources favoring relaxation of the 404 program contend that States are capable of providing adequate wetland protection and, indeed, are better suited to do so, both in terms of knowledge about their own resources and in terms of what observers see as the desirable amount of power States should possess vis-à-vis the Federal Government.

Some of the above arguments can be viewed from a different perspective. Between the mid-1950's and the mid-1970's, about 500,000 acres of wetlands were converted to other uses each year. Also, conversion rates differ for different types of wetlands and for different areas of the country. Some wetlands are under much greater pressure than the national figure indicates. For example, conversion rates for the Lower Mississippi Alluvial Plain between the mid-1950's and the mid-1970's were three times higher than the national average. Conversion rates for freshwater emergent wetlands in this period were four times greater than those for freshwater scrub/shrub.

---

*This was stated by several industry representatives in talks with OTA staff, and no association has explicitly challenged this notion in its public statements on the 404 program.

[10] Julian Simon, "Are We Losing Our Farmland?," *Public Interest*, No. 67, spring 1982, p. 53.

[11] Pacific Legal Foundation, "A Report to the Presidential Task Force on Regulatory Relief in Support of the Army-OMB Regulatory Prop sals for Clean Water Act Section 404," Mar. 18, 1983, pp. 11-12. This reasoning is rather unfair, as IWR was only considering losses in the approximately 90 million vegetated wetland acres of the continental United States.

[12] Alaska Corps District, as reported in ESA/Madrone, "Wetlands and Regulation: Alaska Case Study," contract study for OTA, January 1983, pp. 2-11.

In addition, it is very difficult to estimate what conversion rates would be without the program. Although efforts are being made to reduce duplication between State and Federal programs, substantial duplication exists in some States, increasing costs to applicants in various ways including, for example, in added filing fees and in time spent in preparation and discussion of applications. Permit applicants must sometimes explain their projects to different sets of governmental personnel or endure one agency denying a permit after another has approved it. Whether these drawbacks are warranted depends on how the results of duplication are judged. Many observers, including many States where duplication is present, believe that the positive general results of duplication outweigh the disadvantages to applicants, such as increased assurance that violations missed by one level of government will be dealt with by another. In addition, duplication is less common than lack of duplication—the 404 program is the only available means of wetland protection in many areas of the country.

### Congressional Intent

Some sources contend that the current jurisdiction of the Corps under the 404 program, the 404 program's presumption in favor of wetlands, and its protection of wetlands for reasons other than the narrow grounds of water quality, were not intended by the Congress when the Federal Water Pollution Control Act was passed and amended.[13] In support of these contentions, the following arguments are made:

- Section 404 of the Clean Water Act (CWA) does not mention wetlands. Wetlands are mentioned in the report supporting the 1977 amendments to the CWA. It also is argued that Congress originally intended historically navigable waters to be regulated. Certain Federal court decisions and agency discretion in rulemaking, rather than congressional action, have expanded the program into its current form. This extension is held to constitute unwarranted Federal involvement in land-use decisions.
- The appropriateness of regulating wetlands that do not conform to popular definitions of swamps, marshes, and so forth is especially controversial. Wetlands that are only infrequently under water or that are the byproduct of manmade activities (e.g., drainage ditches or structures) have been the subject of several battles between the Corps and developers (8). Regulation of Alaskan tundra, playa lakes, and several other specific types of areas as wetland also is controversial.
- Because section 404 has obvious deficiencies in the protections it offers to wetlands, as explored later in this report, it can be argued that it should not be seen as a wetland-protection statute. If Congress had wished to protect wetlands, it would have written more explicit language to that effect.
- The intent of Congress in passing CWA was to safeguard water quality, narrowly interpreted to refer to water pollution. If wetlands are to be protected under the act, it is argued, this protection should only be extended when the water quality benefits of wetlands are endangered. Further, it is believed that only *interstate* water quality benefits of wetlands clearly fall under the purview of the act.
- The current mode of operation of the 404 program is held to conflict with more clearly expressed congressional intent to encourage agriculture and other types of development activities.

Opposing these contentions, environmentalists and other sources have argued that Congress has strongly recognized wetland values and has at least implicitly approved the current scope of the program by not excluding wetlands, adopting a narrow navigable-waters standard, or restricting the program to water quality, when it passed amendments to the act in 1977. Parties favoring the current geographic scope of the program also can point to language in the legislative history of the act calling for a broad interpretation of its scope. Environmentalists also believe that the objective of CWA—to "restore and maintain the chemical, physical, and *biological* integrity of the Nation's waters"

---

[13] For example, Pacific Legal Foundation, op. cit., pp. 8-9; Gary E. Parish, J. Michael Morgan, "History, Practice and Emerging Problems of Wetlands Regulation: Reconsidering Section 404 of the Clean Water Act," *Land and Water Law Review*, vol. 17, No. 1, 1982; Washington Legal Foundation, "The Feds: Even Dry Land is Wetlands," 1982. See also statements by Assistant Secretary of the Army Gianelli in *National Journal*, Mar. 6, 1982, pp. 412, 413.

(emphasis added)[14] justifies the protection of wetlands for other than water-quality reasons, in particular, to safeguard wildlife habitat.

### The Presumption of Wetland Value

Prior to the suggested regulatory revisions of July 1982 put forward by the Corps, the Corps reviewed permit applications with the presumption that, "Wetlands are vital areas that constitute a productive and valuable public resource, the unnecessary alteration and destruction of which should be discouraged as contrary to the public interest."[15] In this view, the benefits of proposed projects must outweigh the damage to wetlands, and the proposed wetland alteration must be necessary to realize the benefits. If a proposed activity is not water-dependent—if a feasible alternate site is available—it normally will be denied. Further, all appropriate and practicable steps must be taken to minimize potential adverse impacts of the discharge in question. Parties opposed to these provisions have the following arguments against the above presumptions:

- The benefits of wetlands often are difficult to discern and measure. Not all wetlands are of equal value, and many wetlands are regarded by various sources as being of little value to society. In particular, the water quality values of many wetlands protected by the program are questionable; as mentioned, some sources believe that only protection of water quality is mandated by CWA.

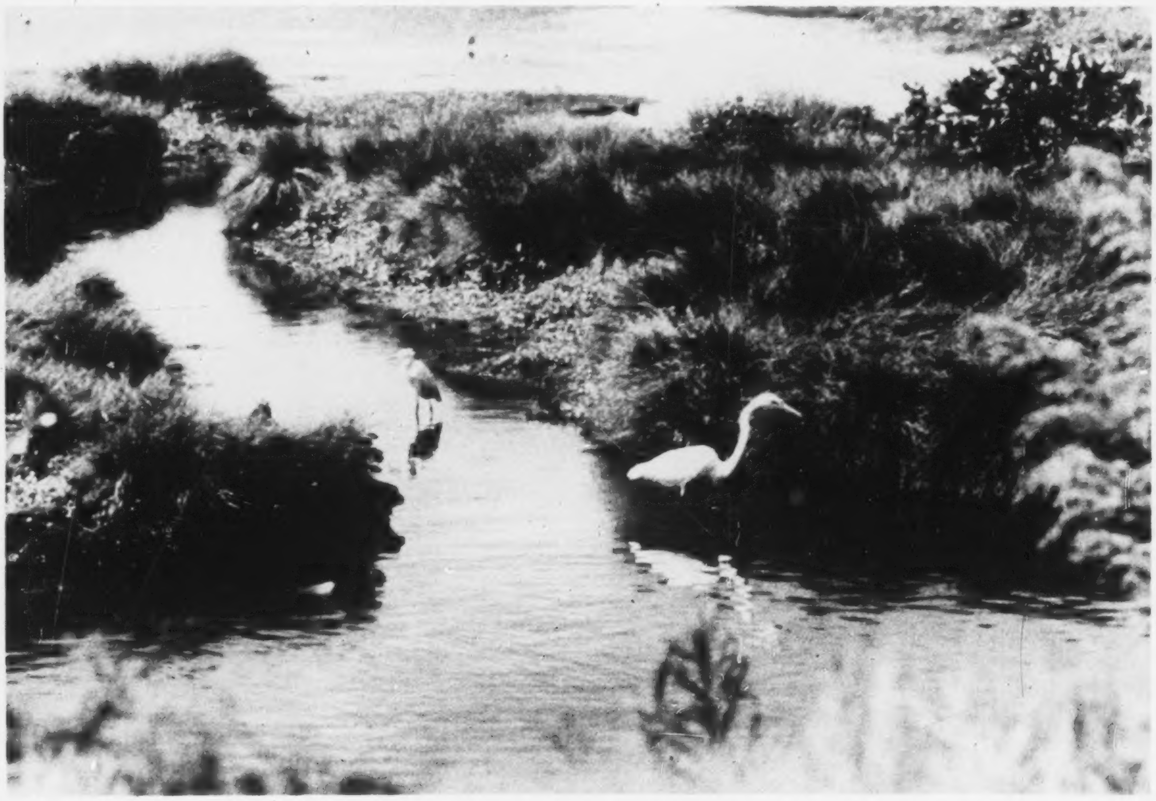


*Photo credit: U.S. Fish and Wildlife Service, Bill Gill*

Prior to the Corps' suggested regulatory revisions of July 1982, the Corps reviewed permit applications with the presumption that, "wetlands are vital areas that constitute a productive and valuable resource, the unnecessary alteration and destruction of which should be discouraged as contrary to the public interest"

---

[14] Clean Water Act, sec. 101(a).

[15] 33 CFR, sec. 320.4(b)(1).

- In specific permit decisions or in general, parties seeking to change the program hold that development values outweigh the benefits of natural wetlands. Employment, balance of payments, energy supply, and so forth are contrasted to the less quantifiable benefits of wetlands. Development values are held to be of national importance, while wetland values may be seen as having only local applicability.[16]
- Wetlands also may be contrasted to other lands in terms of their environmental benefits. For example, while some environmentalists see wetlands as the most valuable type of undeveloped area, others prefer upland environments. Many State resource agencies support schemes that create upland environment for nonwetland game species.

In summary, it is argued that, at most, section 404 should cover only wetlands of clear benefit to society. There should be no presumption that all wetlands are valuable. Secondly, a more explicit balancing of the values of conversion with the values of preservation of wetlands should be made. Some proposals would reverse the presumption of wetland value to a presumption of development value and would hold that unless an application can be demonstrated to injure the wetland, or even more narrowly, water quality, the application should be granted without the imposition of modifications.

In contrast, defenders of the program argue that all wetlands are valuable, albeit to varying extents. A presumption of value therefore is appropriate and necessary to reverse what some view as a disastrous rate of wetland conversion. Under treaties, conventions, and agreements, the United States has public trust responsibilities for resources, including migratory birds, anadromous fishes, and threatened and endangered species. Destruction of upland environment to protect wetlands is the result of a lack of comprehensive planning and poor coordination between agencies rather than an inherent flaw of the 404 program.

The July 1982 revisions changed the strength with which the presumption of wetland value is applied, i.e., by removing the provision that wetland alterations must be necessary to realize project benefits. The presumption that "wetlands are vital areas . . . " was changed to "*some* wetlands are vital areas . . . " (emphasis added).

### Program Administration

The administration of the 404 program has been criticized by a number of sources for three reasons:

- Those planning to conduct activities in wetland areas, especially individuals and small firms, often are unaware of or confused by program requirements. There often is uncertainty whether a particular area is a wetland. Definitions of wetlands used by State and Federal agencies often differ and may be difficult for nonspecialists to use to verify whether their land is covered by a regulatory program. For example, many plant species are found in both wetlands and nonwetlands. Determinations of whether wetland species are "prevalent" in an area under consideration can be controversial. There is much desire that the Corps publish easy-to-use guidelines on how to identify wetland areas.
- Some firms claim that the modifications imposed by Federal agencies are unreasonable—e.g., that the activity applied for is not overly impacting wetlands or water quality—or that the firm's own planned mitigation practices are adequate, and there is no need for the additional mitigation often required by Federal agencies (9).
- In the eyes of many permit applicants, delays resulting from agency permit processing seem unreasonable. Requests for additional information about projects often are seen as unnecessary. Some Corps districts are also thought to be unwilling to take a strong role in resolving disputes if any local, State, or Federal agency has any objections to the proposed development. Permit applicants and agencies are left to fight out problems among themselves, a situation seen as favoring agencies (10). On the other side, defenders of the program argue that while some exceptions may exist, the modifications required and the amount of time taken by Federal agencies have not been unreasonable considering the need for caution in dealing with project impacts.

---

[16] Parish and Morgan, op. cit., p. 79.

## *Specific Impacts of the 404 Program*

Costs related to the 404 program may be divided into two categories: national costs and costs to individual permit applicants.

### National Costs

Overall, the greatest potential impact on development activities from the 404 permitting process is the *prevention* of activities. In some cases, resources cannot be extracted, facilities built, and so forth, because of denials of permit applications (assuming that alternative means of conducting the activity cannot be found) or if delays, modifications, or other costs make the planned activity uneconomical or otherwise infeasible to undertake. Activities that are not prevented may be made *more expensive,* thus increasing costs to users of the products produced. These general types of impacts can have broader effects than just the costs to the permit applicants.

Potential national costs include reductions of production and price increases in regulated industries and other industries dependent on regulated firms. One oil company argued, for example, that 404 regulation is economically unproductive, adds no resources to the Nation, and creates many millions of dollars in costs that are "inevitably passed on to consumers and contribute to America's current economic malaise."[17]

In addition, if regulatory restrictions make wetland portions of a resource base impossible or more expensive to use, the remaining nonwetland portions also may become more valuable as a result of the diminished supply of the resource in question. While this outcome may not increase costs to the firms exploiting the resource, it could result in increases in the prices charged to consumers of the products derived.

Some industry associations and individual firms contend that the macro-level effects of the 404 program are of a different type than are direct effects on the gross national product (GNP) or consumer prices. They argue that a deleterious effect of the 404 program on the operations of various industries adversely affects vital national interests. For example, petroleum industry members have stated that the 404 program has seriously interfered with the ability of the oil industry to explore and develop Alaskan North Slope oil reserves, which comprise roughly 40 percent of U.S. domestic reserves. They state that Alaskan reserves are "of obvious and crucial importance to America's domestic oil supply, and thus to American national security interest."[18]

OTA does not have sufficient information to determine the impacts of the 404 program on any sector of industry, on national indicators such as GNP, or on national interests in general. At least some individual firms have borne major costs as a result of the 404 program, and industry associations brought to OTA's attention instances in which costs ran into millions of dollars. The significance of these costs beyond the impacts to the firms concerned is difficult to assess. To some industry associations, the 404 program is one of the major sources of regulatory costs.*

OTA asked associations to estimate the significance of 404-related costs—e.g., the proportion of the total burden of Federal and State regulation entailed by the 404 program—and the importance of 404 program costs relative to other factors, such as high interest rates. Several associations said that the significance of program costs varies with the project. Two associations made more specific estimates. The range of the responses received by the FI from 2 firms in North Carolina was 10 percent and 50 percent; from 14 firms in Florida, 1 to 40 percent, with a median of less than 5 percent. The American Paper Institute/National Forest Products Association (API/NFPA) responded as follows:

> The significance of section 404-related costs to our members has decreased steadily since the mid-1980 publication of the regulations implementing section 404(f). As a consequence, it may now be less significant than requirements imposed by other Federal or State programs.

---

[17] Sohio, "Briefing Paper for Regulatory Changes to Corps of Engineers Regulations Governing Section 404 of the Clean Water Act and Sections 9 and 10 of the River and Harbor Act of 1899," 1981. It was claimed that in one project alone, 404 problems caused tens of millions of dollars in costs.

[18] Ibid.

*For example, API listed section 404 permitting second in a list of 10 highest priority issues submitted to the Reagan administration, May 4, 1981.

> Immediately after the expansion of the section 404 program to nonnavigable waters in 1975, we anticipated over 180,000 permit requirements per year for forest management activities. As the result of the passage of section 404(f), this problem has decreased to 0.1 percent of our original projection. We would currently estimate section 404 as representing a relatively small proportion of the total burden of Federal and State regulation that our industry faces.
>
> With respect to the importance of section 404, compared to general economic conditions; high interest rates (to use the example cited) have resulted in the poorest forest products market since 1930. Consequently, compared to current economic conditions section 404 is a relatively minor concern.

The IWR report found that changes in the national economy caused by the 404 program are difficult or impossible to measure (e.g., using the GNP or consumer price index (CPI) figures). It concluded that while impacts on individual firms could be significant, such impacts are unlikely to have any major effect on the national economy.[19]

The impacts of the 404 program on national security concerns are unclear. For example, Alaskan energy development appears to be subject to permitting delays more from State agencies than from the Federal agencies involved in the program. It could be contended also that the development activities affected by section 404 are not constrained to such an extent that national security is threatened. For example, it could be argued that sufficient amounts of the resources in question can be obtained from nonwetland areas to meet U.S. needs.

One study of the effect of section 404 on the deepening of coal ports concluded that 404 reviews have not and are not likely to constrain either such deepening or the development of U.S. coal exports. Delays in port dredging are attributable to other sources.[20]

Environmentalists are quick to point out that there may be national costs associated with degradation and conversion of aquatic habitats required to sustain wildlife. National estimates for 1980 show that commercial and noncommercial activities associated with fish, wildlife, and associated outdoor activities are worth many billions of dollars per year. Some of these economic values are described in chapter 3. Maintenance of the habitat base required to perpetuate wildlife resources is important for economic as well as other purposes.

### Costs to Permit Applicants

Major categories of costs to applicants for 404 permits involve processing, modification, delay, and opportunity.[21] These costs are borne not only by permit applicants but also by people who would otherwise benefit from the activities permitted. Projects that are abandoned, made less profitable, or never initiated mean potential losses in job opportunities, economic development, and tax revenue. On the other hand, protection of wetlands has its own set of benefits that may include higher returns in some areas. In addition, losses both to project initiators and potential beneficiaries will be offset if, as is likely, the resources that would have been used in a wetland-related project are used in some other fashion. From the standpoint of the national economy, there might be no net change. However, great changes in which areas experience benefits could result.

Finally, there are nonquantifiable costs to the permit process, such as the energy and aggravation entailed in filling out forms and meeting with agency officials.

---

[19] Institute for Water Resources, op. cit., p. 184. The IWR report concluded that it is likely that all Federal environmental regulation combined has had a very small effect on the GNP and CPI, and the 404 program is only a small part of this regulation. See also the Western Governors' Policy Office, "Permitting and Siting of Energy Projects: Causes of Delay, and State Solutions," Denver, 1981, which concluded that environmental regulations constituted a relatively minor source of delay to energy projects in Western States, as compared with equipment- and labor-related problems.

[20] Michael Rubino, "Dredge or Fill, Section 404, and Coal Port Development," Brookhaven National Laboratory, 1983, pp. 6-7.

[21] Institute for Water Resources, op. cit., pp. 144-145. Categories are modifications of categories listed.

# PROCESSING COSTS

Processing costs are those costs incurred by applicants to produce information needed for the permit process. Such information may include application fees, maps, project plans, and EISs.

Private individuals are charged a $10 application fee for a 404 permit. Permit applications for commercial purposes cost $100. A set of drawings showing the location of the proposed project and the work to be performed must be submitted. Many applicants employ engineering firms to produce such drawings. According to IWR, some firms will handle all procedural details of applications, with fees ranging from $100 to $500.[22]

Applicants may be required to submit additional information beyond what is required normally, however. Applications that appear to have major environmental impacts, for example, often must be accompanied by detailed EISs.[23] The fees paid by applicants to environmental consultants preparing EIS's often are substantial, costing tens of thousands of dollars and representing a major share of permitting costs.* The costs of EIS preparation, however, cannot always be attributed to the 404 program. Authority to require a developer to submit an EIS comes from NEPA, not from section 404. In many cases, if the Corps did not require an EIS for 404 considerations, another Federal agency with permitting authority over the project could require it or be sued by an outside group seeking to make the agency exercise this prerogative. Another major difficulty in estimating the costs of 404 application and preparation is that some, or even most, of the environmental analyses undertaken by firms (which can constitute the greatest source of expense) may be required in any case by States with strong environmental programs and may be undertaken not only for wetland-related concerns but also for other environmental considerations. Also, many firms engage in advance planning and environmental programs of their own, the results of which are used in 404 applications.

The OTA survey asked associations to estimate the costs of application and processing of 404 permits. Most associations said that costs vary with the scope and controversy of the proposed permit. Only a few associations gave quantified estimates. The FI estimate was $1,000 to $3 million. Of the three firms making up the American Waterways Operators, Inc. (AWO), response, one estimated such costs as $500, another's estimate was $20,000 to $25,000, and one said that "costs can run into the tens of thousands of dollars." For the two ports answering this question on the American Association of Port Authorities (AAPA) response, one said that "preproject paperwork" increased by 20 to 50 percent for small projects. The other said that costs can vary from $25,000 to over $100,000.

The response from API/NFPA said that significant costs are experienced occasionally when Federal agency evaluation is necessary to assess the applicability of 404(f) exemptions to a project. In one instance, a firm devoted 120 staff hours to preparing support for its view that planned activities fell under 404 exemptions.

IWR estimated that processing costs in fiscal year 1980 totaled $17.3 million, averaging $911 per application, or $1,226 for government, $652 for individual, and an implied $1,179 for commercial applications.[24] The assumptions and methods by which IWR calculations were made were not explained, and the resulting estimations may be inaccurate (11).

---

[22] Institute for Water Resources, op. cit., p. 146.

[23] *The Washington Post*, Sept. 13, 1982. The number of NEPA suits filed for "projects affecting wetlands or bodies of water" constituted almost 13 percent of all suits filed in 1980, tying for second place among 18 categories.

*The Fertilizer Institute claimed that in one instance fees totaled $3 million.

[24] Institute for Water Resources, op. cit., p. 173. IWR did not give an average for commercial applications. The figure listed here was calculated using IWR figures for the cost borne by different types of applicants and for the number of commercial applications.

# MODIFICATION COSTS

Project modifications made in response to Federal agency requirements or pressure as a condition for permit approval may entail additional outlays by applicants—i.e., to restore or create wetlands, transport material to more expensive upland sites, or use more expensive technology or management practices. In addition, such modifications may reduce the profitability of a project, for example, by making the project smaller. There also may be modification costs not directly required by agencies. Applicants may modify projects before an agency objects to them in expectation of permit denials if modifications are not undertaken.

Rough estimates indicate that one in three permits is modified. The figure is probably lower for small projects and higher for large projects. Many projects undoubtedly were modified in anticipation of comments by Federal agencies; many others were modified as a result of preapplication consultations (12).

According to one supporter of the program, 90 percent of recommendations made by Federal resource agencies to permit applicants during permit review are "accepted" by applicants,[25] meaning that few such suggestions result in the applicant withdrawing a permit application or refusing to make the change. However, the requirement of modifications often has an element of coercion. Apart from the threat of denial of a permit by the Corps or the Environmental Protection Agency, (EPA), Federal agencies without the power to deny a permit could, before the regulatory changes proposed by the administration in 1982, threaten to elevate a decision on a permit to higher levels in the Government, with the concomitant delay entailed in processing. As stated by OMB, the threat of elevation often has caused applicants to "accede to unnecessary and unreasonable changes in their plans" to avoid agency objections.[26]

The cumulative amount of outlays for modifications and the average cost per permit applicant are almost entirely unknown, given present data. IWR estimated that the cost of modifications equals the amount of savings to permit applicants through "technology transfer."[27] These savings were estimated to be 15 percent of site development costs, or an annual amount of $135.5 million to $271 million.[28] However, no basis was given for the assumption that sums for modifications and technology transfer are the same. Further, as previously discussed, the IWR estimate of technology transfer savings is extremely uncertain.

The OTA survey asked associations to estimate the ranges of costs for modifications. Very few quantitative estimates were made. The American Mining Congress (AMC) and the American Petroleum Institute (API) said that modifications range from minor, relatively inexpensive changes to major modifications costing millions of dollars. AAPA said that costs for riprapping increased by 10 to 20 percent.

An example of increased costs was given by API, which said that drilling a 12,000-ft oil or gas exploratory well may cost $2.5 million for a straight hole and $7.5 million when directional drilling is employed. Out of the API survey sample of 40 firms, representing a total of 794 permits from August 197[illegible] to October 1981, 53 cases of increased costs from the adoption of stipulations or special conditions" were noted, totaling $17 million, an average of about $320,000 per case. However, this average is not representative, one permit alone accounted for $10 million in costs. Secondly, not all firms submitted all of their past permitting experiences to API: some firms gave only examples where problems were encountered, possibly biasing the overall picture presented. API also gave an alternate figure: averaging the $17 million figure across all 794 permits, API determined the average cost to be about $22,000.

Among the nonquantitative estimates, API/NFPA said that "with respect to specific project modifications, forest-access road construction usually requires certain modifications (e.g., adequate culverts) to insure flow and circulation when crossing waters or wetlands. This is not a major difficulty. The construction of water intake and effluent-outfall structures must be undertaken in a fashion that does not involve unnecessary disruption of wetland areas. This has not generally proven to be difficult."

---

[25] National Wildlife Federation, op. cit.

[26] Office of Management and Budget, op. cit.

[27] Institute for Water Resources, op. cit., p. 153.

[28] Ibid., p. 135.

# DELAY COSTS

Delays in processing applications past "normal" processing time can result in costs to applicants, such as payments to idle workers and contractors, possible increases in interest rates and prices for raw materials, labor, machinery, and the like. Unanticipated delays are especially costly.

OMB stated that the 404 program has been "plagued by severe delays that have generated complaints and imposed heavy economic burdens on the public" and "has introduced long delays into a substantial number of major permit applications."[29] Such delays are contrary to statutory language in section 404, which requires that memorandums of agreement be concluded among agencies to minimize delays. The major source of delays was said to be the multiple layers of review or elevations of permit decisions possible if another agency disagrees with the Corps.

As the OMB letter did not define "long delays," or "substantial number of major permits," it is difficult to assess the accuracy of its criticism. Opinions differ about what constitutes normal processing time. A coalition of environmental groups believes that 131 days, the average period for processing non-EIS permits from 1977 to 1981, is a reasonable figure.[30] Following the figure employed by RIA, IWR used 120 days. The General Accounting Office (GAO) says 105 days.[31] Some industry spokesmen have used a 90-day figure (13). OMB recommended that 60 days be the normal processing time.

Statutory and regulatory language on processing deadlines provides that the Corps must issue a public notice of a permit application within 15 days of receipt of a *complete* application.[32] Applications lacking required information must be resubmitted. CWA requires that memorandums of agreement be concluded among the Federal agencies involved such that "to the maximum extent practicable,"[33] decisions about permits can be made not later than 90 days after public notice. This deadline allows for some deviation. Federal agencies are given 30 days from the issuance of public notice to forward comments to the Corps; however, they may request extensions of up to 75 days under what are supposed to be unusual circumstances. Section 404(m) directs the Fish and Wildlife Service (FWS) to submit comments within 90 days of receiving the public notice.

In addition to the time allowed for Federal agency action, States are given up to 1 year to perform water quality certifications, which apply to practically all 404 permits. Without such certification, the Corps cannot grant a permit. As discussed below, according to IWR, much of the time involved in processing permits stems from the length of time it takes States to grant 401 certifications. Most States claim, however, that they issue such certifications within 90 days. Arrangements have been made between some Corps districts and State agencies to set time limits on State certifications, after which certification is considered to be de facto granted.

## *Percentage of Permits Delayed*

OTA calculations based on RIA material are that if only issued permits are considered (i.e., not including permit withdrawals and denials), 43 percent of commercial, 29 percent of private, and 33 percent of governmental permits, or 34.5 percent of all permits, took longer than 120 days to process in fiscal year 1980 (14). As described earlier, RIA data include non-404 permits. While it is not certain that these percentages would hold if 404 and 10/404 permits were considered, it is likely that these figures for delay do represent minimum estimates: 404-related permits constituted 54 percent of permits issued in fiscal years 1980 and 1981, and it is reasonable to assume that 404-related permits were, on average, more controversial, and thus more subject to delay, than were non-404 permits. If these percentages are accepted, a substantial number of permit applicants do appear to suffer delays, especially for commercial projects.

---

[29] Office of Management and Budget, op. cit., p. 28

[30] National Wildlife Federation, op. cit.

[31] General Accounting Office (Tech. Note No. 9), p. 28.

[32] Clean Water Act, sec. 404(a).

[33] Clean Water Act, sec. 404(q).

Taking all oil- and gas-related 404 permits in Alaska from February 1980 to September 1981, GAO found that approximately 76 percent took more than 105 days to process, that length of time being GAO's definition of normal processing time. Even using the more generous standard of 130 days, more than half of such permits were delayed.[34]

## Length of Delays

According to IWR, the average Corps processing time for routine permits (permits to which agencies have not raised objections) has been reduced from 84 days in 1977 to 70 days in 1981.[35] As mentioned, another source estimated that average processing time for all permits except those requiring an EIS was 131 days.[36]

By a great margin, permits take longest to process when EISs are required. Based on fragmentary data, IWR estimated that processing such permits takes an average of 815 days.[37] The percentage of all 404 permits that require an EIS, however, is very small, about 0.03 percent. Large-scale projects are affected disproportionately. If permits requiring EISs are not considered, the average length of time to process permits is much less.

The OTA survey asked associations to estimate how long, on average, it takes to receive a final decision on a permit. API reported that processing takes an average of 131 days (median time, 106 days). Routine permits are processed in under 4 months; permits to which objections are made average over a year. These totals factor in permits for which EISs are required. For Alaskan oil and gas permits alone, according to GAO, the average permitting time was 150 days.[38] AMC found average processing time to be 8 months, with routine permits usually processed within 90 days and controversial permits taking an additional 5 or 6 months. FI did not provide an average figure, saying that application approvals take from 2 months to over 3 years. The three firms making up the AWO response reported that processing takes from 3 to 8 months, 4 to 7 months, and "at least" 12 months, respectively. Finally, the three ports making up the AAPA response reported that processing takes 4 to 9 months for routine permits, and several years for more controversial permits.

## Sources of Delays

It is difficult to determine what percentages of delays are due to the various possible sources of delay. OMB focused on delays caused by elevation procedures and found that between March 24, 1980, and an unspecified date, there were 281 cases in which a district engineer proposed to issue a permit over the objection of another Federal agency. Seventy cases, or 25 percent of such cases (and about 0.6 percent of all 404-related permits processed), were elevated. Of these, the division engineer resolved 55 (about 79 percent), for an average delay time of 150 days. Five cases were resolved by the Office of the Chief of Engineers for an average delay time of 320 days. Five cases were resolved by the Assistant Secretary of the Army (Civil Works) for an average delay time of 650 days, and five cases were pending. (It is unclear if these delay times represent additional days over what is considered normal processing time [120 days], or whether they are total processing times.) The average delay for the 70 cases was 202 days. OMB also stated, without listing a source, that the *threat* of elevation affected an additional 1,700 cases, causing an average delay of 75 days. Of the 70 cases in which permits were elevated as described by OMB, requests for elevation were made in 50 days by FWS, 36 by NMFS, and 16 by EPA (elevation requests are sometimes made by more than one agency).

---

[34] General Accounting Office (Tech. Note No. 9), p. 28.

[35] Institute for Water Resources, p. 39.

[36] National Wildlife Federation, op. cit.

[37] Institute for Water Resources, op. cit.

[38] General Accounting Office (Tech. Note No. 9).

It has been argued, however, that these agencies have steadily reduced processing delays and only rarely elevate permits. According to FWS statistics for the period July 1 to December 31, 1980, average processing time was 17.2 days for routine permits and 22.5 days for all permits. FWS requested the elevation of 42 out of the 6,376 received 404 and 10/404 public notices, about 0.7 percent. Of these, resolutions in the permit applicant's favor were made in 15 cases; in FWS' favor, in 2 cases; and a compromise was made in 25 cases. Of the four cases elevated as high as the Washington level, two resolutions were made in the applicant's favor, with two compromises.[39] In the NMFS Southeast region, which handles about half the NMFS 404 workload, 97 percent of the 5,240 permits reviewed were handled within 30 days in 1980.[40]

According to IWR, elevation requests and handling by Federal agencies are not the only, or even the primary, source of delays. In order of importance, the following sources of delay were mentioned by Corps districts in response to the RIA questionnaire:

### Applicant Behavior

Many permit applicants fail to provide sufficient information on applications, leading to requests for additional information by Federal agencies and delay for the applicant. One possible reason for this problem, suggests IWR, is that application requirements are complicated and beyond the capability of many applicants.

### State Water Quality Certification

As mentioned, section 401 of CWA requires all 404 applicants to obtain a certification or permit from the State in which the discharge of a pollutant may take place to the effect that the discharge will comply with applicable State standards. States are given a period not to exceed 1 year to make a decision on whether to give such certification, after which this requirement is considered to be waived. In the absence of 401 certification, a 404 permit will not be granted by the Corps. A number of States use 401 requirements as a way of gaining concessions from permit applicants without having to establish explicitly a separate wetland-protection program.

### Manpower

Corps district personnel responsible for processing applications are unable to keep pace with the number of permit applications received. Manpower was not expanded when the Corps expanded its activities from phase I to phase II and III waters.

### FWS Comments

Although FWS actually elevates relatively few permits, it has exercised considerable influence by threatening to elevate permits unless applicants implement changes in their applications. To avoid the greater delay of elevation, applicants accept the lesser delays entailed in revising applications to meet FWS concerns.

Other sources of delay were not judged by Corps districts to be nearly as significant as the above four causes.[41]

The relative importance of these sources of delay varies with the Corps district, State, and project involved. For example, in most cases, State certifications become factors in delay only when projects are controversial, large in size, or otherwise difficult or complex to evaluate. Many States say that delays come from poor applications and poorly planned projects: time is taken to assist applicants in resubmitting or even redesigning applications and projects. Most States responding to the OTA State survey claimed that they process routine 401 and 404 permit applications and applications for State permits within 2 months, with more major applications taking longer (6 months, or in exceptional cases, even years). While there are few data on the proportion of projects that are delayed by

---

[39] U.S. Fish and Wildlife Service, "Fact Package," Feb. 26, 1982.

[40] Natural Resources Council of America, "Statement on 404," Mar. 5, 1982.

[41] Ibid., pp. 180-183. Corps delays in issuing public notices in Alaska were ascribed by GAO to Corps manpower problems. Rather than the 15-day period mandated, the Alaska district averaged 21 days, with two-thirds of the notices late in issuance in fiscal year 1981 (down from 28 days and 71 percent delayed in 1980). GAO made a similar finding in 1980 for three other Corps districts. GAO (Tech. Note No. 9), p. 30.

State processing, several States said that only a small percentage are delayed (e.g., Massachusetts stated that 90 percent of its projects are processed within 2 months).

### Estimates of Delay Costs

Very little information is available bearing on the monetary costs of permit processing delays. OMB, evidently using the IWR analysis, put such costs at "over $1.5 billion."[42] The IWR estimated delay costs, including opportunity costs due to delay, to total $1.7 billion. The extremely complicated formula used by IWR to calculate delay costs entailed many assumptions for which no basis was provided. Some data that went into the calculation almost certainly were inaccurate. For these reasons, the IWR estimate is of uncertain reliability (15).

Only one industry association made a specific monetary estimate of delay costs: FI put the range of such costs at $17,000 to $2.2 million. The $2.2 million estimate was based mostly on opportunity costs: according to one firm, delay made it necessary to cancel a mining project, thereby negating previous sums spent on environmental studies and foregoing the value of the resource. Individual accounts of increased costs from delays are frequent. One application in Alaska by an oil company to construct a drilling mud pit took 225 days to process, mostly as a result of repeated extensions granted to an Alaskan State agency. The company involved claimed that project costs more than doubled, mostly because construction was moved from summer to winter.[43] Two other estimates from the petroleum industry also indicate substantial costs: API stated that 55 permit delays in southern Louisiana cost firms $19 million (with "lost or deferred production" totaling 428,000 barrels of oil and 14.9 billion cubic feet of gas as a result).[44] Another industry study claimed that 57 out of 89 oil- and gas-related permit applications experienced delay-related economic losses.[45]

---

[42] Office of Management and Budget, op. cit.

[43] General Accounting Office (Tech. Note No. 9).

[44] Ibid.

[45] Mid-Continent Oil and Gas Association, 1979, quoted in Institute for Water Resources, op. cit., p. 175.

## OPPORTUNITY COSTS

Opportunity costs are created when the permitting process denies applicants the use of capital, labor, and machinery that could otherwise produce an investment return. For example, modifications to projects that require additional outlays by the applicant may create opportunity costs, assuming that the funds going into modifications could be used in other ways that would generate more revenue than that produced by the modification. Similarly, delays could mean that investments sunk in project planning and kept in reserve for project implementation remain idle rather than produce revenue when expected. In some cases, delay produces opportunity costs when the opportunity to exploit a resource is withdrawn, owing to delay (e.g., if time-based leasing arrangements are not fulfilled). Even normal processing of permits produces opportunity costs in time and money that conceivably could be used elsewhere to produce a greater return.

Denials and withdrawals of permits presumably create opportunity costs greater than those of normal processing, as no return is realized from the resources spent on such permit applications. Opportunity costs in terms of the value of lost raw materials also are created when permit denials prevent a resource from being exploited if an alternate plan of resource extraction subsequently cannot be worked out.

An even more speculative category of opportunity costs is costs related to planned projects that never were submitted as permit applications out of fear, perhaps based on meetings with Federal officials, that they would be denied or modified in a way unacceptable to the applicant.

Opportunity costs are the most difficult of all the costs listed to estimate. It is possible to approximate roughly the number and proportion of projects subject to such costs beyond the opportunity costs associated with normal processing. In fiscal year 1981, 291 permits were denied to section 404 and 10/404 projects, about 2.7 percent of total permits processed. About 14 percent, or 1,545 permits, were withdrawn. As stated in the IWR report, not all withdrawals can be attributed to the regulatory program. Other factors, such as changed economic conditions, can cause applicants to change their plans. However, the majority of withdrawals probably stem from difficulties encountered in the course of agency review of permit applications. As discussed earlier, roughly one-third of issued permits are modified substantially; about the same percentage are delayed. Some overlap probably exists in these last two categories. It also is likely that of permits not issued, some proportion were in processing for over 120 days; however, no estimate is available of what this figure might be. At minimum, the percentage of delays/modifications, withdrawals, and denials can be added together, resulting in a figure of at least half of all permits that experience opportunity costs beyond those associated with routine processing.

A large part of the problem in estimating opportunity costs is the difficulty of getting objective information. Investments are not necessarily idle, even if "sunk" in a project. For example, machinery may be contracted out to other firms. In some industries, some periods of the year normally are slack, and permit delays cannot justly be regarded as the source of idle labor and machinery. However, few 404 program critics volunteer such information. To give a more common example of the difficulty in making estimates, modifications of permits often require changing the timing of a planned activity so that it will have less impact on various wetland species of animals (e.g., not performing the activity during spawning season). Delays also will affect project timing. The cost of the impact depends on the extent to which the applicant already has committed resources to the time originally asked for in the permit. This will only be known to the permittee. According to Corps personnel, consultations before permits are submitted will make it known to prospective applicants what generally can be expected; hence, to commit large amounts of time and money in advance to a project before submitting an application is not prudent, and delay costs, if they occur, thus are not entirely due to Corps actions.

Few estimates of opportunity costs were given by associations. According to FI, the value of 33.5 million tons of phosphate rock underlying 2,862 acres not approved for mining in permit applications from 1975 to the fall of 1982 totaled between $804 million and $838 million per ton at 1982 prices. The IWR's estimate of opportunity costs—apparently including only such costs that are related to modifications—was $409 million, with median costs of $13,523 for commercial projects, $8,000 for government, and $263 for individuals.[46] As with other IWR estimates, these figures suffer from more or less serious methodological difficulties (16).

---

[46] Institute for Water Resources, op. cit., p. 174. See pp. 153-157 for methodology.

# DISTRIBUTION OF COSTS

As highlighted by IWR, the manner in which the costs of a regulatory program are distributed across different sectors of society is of interest. Respondents to the RIA were fairly consistent in their classification of those sectors of industry and society that they rated as being negatively affected. The great majority of responses rated residential development, small business, the manufacturing industry, and the mining industry as suffering adverse impacts from the Corps regulatory program. Oil and gas development was highlighted specifically by several respondents. Somewhat less but still large majorities also saw negative impacts occurring in the "business-commercial-industrial sector" and in the construction industry.[47]

---

[47] Institute for Water Resources, op. cit., p. 175. "Transportation Utilities" were also rated by IWR as being negatively affected; however, responses to the RIA questionnaire were divided almost evenly.

Some costs are borne by taxpayers. IWR estimated that the regulatory functions program of the Corps had a budget of $41 million in 1980. IWR accepted an estimate that other agency support totaled one-fourth of the Corps' effort, an additional $10.25 million. These figures may be high, as they encompass activities outside of 404 administration. On the other hand, the budget may be understated. For example, Corps employees from branches other than regulatory may work part time on permitting matters but are not counted as regulatory branch employees. It is difficult to get exact estimates, because the Corps districts apparently do not keep separate records for 404 expenditures. The fiscal year 1982 Corps budget for 404 and section IV was approximately $50 million, with 800 people on the regulatory staff nationwide.

# CHAPTER 7 TECHNICAL NOTES

1. Much of the quantitative information presented in the IWR report is of questionable quality. Where this information is used in this report, the limitations of the data are examined. In many cases better data were available or collected for this study. For example, the IWR report is quoted often as evidence that the 404 program is responsible for "saving" about 300,000 acres of wetlands that otherwise would be developed if the 404 program did not exist. However, it is unclear how this IWR estimate was made. Since the Corps now is regulating those activities that were responsible for the conversion of about 175,000 acres of wetlands per year between the mid-1950's and the mid-1970's, it is highly unlikely that the 404 program could be saving almost twice this acreage, even if all permits were denied. In fact, data recently collected from all Corps districts and presented in this chapter suggest that this IWR estimate is about six times too high.
2. Activities also may be altered to fall under nationwide permits or exemptions, with benefits to applicants but with less clear benefits in terms of wetland protection.
3. Many districts did not separate estimates on a yearly basis, instead giving totals for 1980 to mid-1982. These were divided by 2.5 to derive a yearly figure.
4. OTA mailed surveys to 20 industry associations. The following associations provided responses: American Association of Port Authorities (AAPA), American Farm Bureau Federation (AFB), American Mining Congress (AMC), American Petroleum Institute (API), American Paper Institute/National Forest Products Association (API/NFPA), American Public Power Association (APPA), American Waterways Operators, Inc. (AWO), The Fertilizer Institute (FI), National Cattlemen's Association (NCA), National Association of Conservation Districts (NACD), and National Association of Home Builders (NAHB). Not every association answered every survey question.
5. Sectors considered were: business-commercial-industrial, agricultural, fishing, mining, construction, manufacturing, transportation utilities, wholesale trade and retail trade, residential development, land values adjacent to permit areas, small businesses, general public, private individuals, government, and public service.
6. The IWR report said that wholesale and retail trade also benefited. However, OTA's examination of RIA responses shows that a slight majority of districts believed that this sector was negatively affected by the program.
7. In its unpublished and quickly prepared report, the IWR used what in effect were educated guesses by Corps personnel to calculate savings to applicants. These percentages were applied to the number of permits *processed* (18,939 in 1980) rather than the number of permits *issued* (16,286)—a 16-percent difference (the number of sec. 404 and sec. 10/404 issued permits was 8,013; the remainder were sec. 10 permits). It is possible that permit applications denied or withdrawn experienced similar amounts of benefits as those submitted. For example, as a result of discussions with agencies, projects could be reconfigured to fall under general permits or be conducted on nonwetland areas with savings over original plans. On the other hand, it is likely that at least some applications were withdrawn, owing to the expense of complying with potential requirements, and that alternate projects were not initiated or were more expensive than those originally envisioned.

   Site development costs were assumed to be 25 percent of the total costs of projects; no rationale was given for this percentage. Further, no basis was given for the figure of total costs ($217,619 million) of projects. Even if these estimates were accepted, IWR calculations of benefits almost certainly are overstated, due to two factors:

   1. Large projects represent an overwhelming share of the total costs of projects (in the first IWR draft, 20 percent of applications were said to account for 95 percent of economic impact [1-7]), yet these are the least likely to benefit from technology transfer. It is likely that large firms planning large projects already will have discovered the least expensive way (though not necessarily the least environmentally damaging way) to develop such projects without benefit of Federal advice.
   2. According to the IWR, report itself, at least some sectors are negatively affected by the program. Based on responses to the RIA questionnaire, these sectors include the business-commercial-industrial sector, the mining, construction, and manufacturing industries,

residential development, and small business. These sectors clearly encompass a large share of the total project cost figure given by IWR, yet logically should not be included in a calculation of benefits.

Last, the rationale for the amortization factor is not explained. If annual benefits are amortized so that only a small proportion is calculated to appear yearly, the total yearly benefits of the program would consist logically of not only the amortized figure for that particular year, but also the amortized benefits from *previous* years. This is not shown in the IWR estimate. The flaws in the IWR estimate are brought out more clearly when the amortization factor is eliminated. Accepting the IWR's figures without amortization, the annual benefits of technology transfer would be from $1.2 billion to $2.4 billion.

8. "In the case of 'Madrona Marsh' in Torrance, California, the Army Corps asserted jurisdiction over the area on February 27, 1980. The area known as the 'marsh' is located approximately two and one-half miles east of the Pacific Ocean and 15 miles southwest of the Los Angeles City Civic Center in a heavily developed commercial area of the City of Torrance. The 'marsh' is not a natural phenomenon, and in fact, did not exist until the late 1960's when it was 'built' as a sump by the City of Torrance to solve a localized drainage problem. In 1981, a petition for withdrawal of claim of jurisdiction was filed with the Army Corps. Jurisdiction was subsequently withdrawn, but in February of 1982, the Army Corps decided to review the decision of the district engineer withdrawing jurisdiction. It has been over two years since jurisdiction was originally asserted, yet under the current regulations and jurisdictional memorandum of understanding, there has been no final determination by the Army Corps." Pacific Legal Foundation, *op. cit.*, p. 17. See also Washington Legal Foundation, *op. cit.*, pp. 2-3.

9. One industry response (API/NFPA) stated that in some cases, permit reviewers required modifications to enhance wildlife habitat even though the requested modifications were not related to the habitat impact of the project concerned. This type of problem was said to be declining.

In Alaska, some permits prohibit drilling except during winter, require that pipelines reach certain heights at animal crossings, and require that impermeable waste disposal pits be constructed. These stipulations are termed controversial by a GAO report because they are costly and their effectiveness has not been established. Often, stipulations requested by other Federal agencies are accepted routinely by the Corps. For Alaskan oil and gas permits, GAO found that 40 percent lacked "site-specific support" from February 1980 to September 1981. (GAO, "Developing Alaska's Energy Resources: Actions Needed to Stimulate Research and Improve Wetlands Permit Processing," June 17, 1982.)

Some Corps districts feel that other Federal agencies act unreasonably. For example, the Charleston district stated in its response to OTA's questionnaire: "This District frequently sees applicants deferring in the interests of more expedient application processing to somewhat questionable project modification imposed as conditions of 'no objection' by Federal environmental agencies. Many of these modifications serve no useful purpose and act to increase project costs needlessly."

The Corps' Pittsburgh District responded: "When dealing with the Fish and Wildlife Service and the Environmental Protection Agency, all wetlands are determined to be of the highest quality and any application for filling wetlands, regardless of true quality, brings a recommendation for denial."

10. As with stipulations, GAO found that extensions of time to Federal and State agencies to comment on permits often were allowed by the Corps without sufficient documentation of the need for such extensions by the requesting agencies. Lack of documentation greatly decreased, however, after March 1980 Memoranda of Agreement (MOA) were signed between the Corps and other involved Federal agencies. Problems continue with State agencies. Further restrictions on reviewing times were contained in 1982 MOAs.

11. To give several examples of problems with IWR calculations:

The IWR gave average costs to applicants for routine permits (those taking under 120 days to process) as $250. No basis was given for this figure, which is not even the midpoint between $100 and $500, the range given by IWR for fees charged by firms assisting permit applicants.

To estimate total costs, IWR multiplied $250 by the number of permits estimated as taking 120 days or less to process. For permits taking over 120 days, IWR listed the average processing time for permits not requiring an EIS as 251 days and for permits requiring an EIS as 815 days. To calculate additional processing costs for these cases, IWR multiplied $250 by 2 and 7 to arrive at $500 and $1,750, respectively. Apart from the questionable validity of including EIS costs and the problems of using the $250 figure, no evidence was presented justifying the estimates of average processing time. Estimates evidently were based on a question on the RIA questionnaire that asked each Corps office to describe three permit cases, which would produce a nonrandom sample of small size (114 examples) when compared to the thousands of permits in various categories (e.g., total issued, total delayed, total processed).

Even if IWR assumptions are accepted, the calculations of total cost and of average processing costs to applicants presented by IWR appear to be incorrect. IWR did not present an explanation of how estimates were made. Using IWR figures of average cost and RIA questionnaire figures on numbers of permits handled in various categories (which also were used by IWR), OTA arrived at different estimates. For example, IWR gave a figure of $4.8 million for the cost borne by all applicants for routine permits. The RIA questionnaire listed a total of 10,688 permits falling in this category, an amount which multiplied by $250 totals $2.67 million.

12. In response to a question on the OTA survey on how often modifications are required, only 1 association made a numerical estimate: FI said that 7 out of 14 projects had modifications requested of them. Nine out of seventeen projects incorporated modifications in anticipation of agency objections.

13. American Petroleum Institute representative before NACOAA meeting, December 1981. Some industry association staffers also have suggested that the time at which the permit process can be said to begin should be pushed back to the preapplication consultation stage, not so much to include this time in statutory limits on processing, but to give a better sense of the total length of time spent by industries in processing.
14. As far as overall percentages are concerned, the inclusion or exclusion of EIS permits makes an insignificant difference as so few EISs are required by the Corps: 47 in fiscal year 1980, including non-404 permits.

    IWR estimates of the percentage of permits delayed were 36.3, 24.7, and 29.8 percent, respectively, for commercial, private, and governmental permits. However, these estimates are inaccurate, even if RIA figures on which IWR based its estimates are correct. IWR used the total number of permits, including denials and withdrawals, in its percentages, but the RIA survey only calculated the number of issued permits that were delayed.
15. The IWR did not write down the calculations it performed to arrive at its estimate; therefore, it is impossible to validate the figure of $1.6 billion. Many unproven assumptions were employed (e.g., projects costing $50 million and under were postulated to take 1 year to complete and be one-third complete at 120 days; projects over $50 million were to take twice as long). Heavy reliance was placed on the small, nonrandom sample of 114 cases described earlier (footnote 13), e.g., to derive median cost figures.

    Problems with the IWR methodology are exemplified in the use of one key piece of data. To determine the costs of projects subject to delay and to apply calculations of delay costs for different types of projects, IWR employed an RIA table giving percentages of how many projects fall into different categories of dollar cost (e.g., it was estimated that 46 percent of all projects are under $25,000; 17 percent from $25,000 to $100,000). This table may be inaccurate. It was based on estimates from Corps personnel from each district who were not asked to supply hard data justifying estimates. The question generating the table was worded such that respondents were asked to estimate projects according to their "potential economic impacts on your region and/or nation," a far different basis than project cost alone. In addition, each district was treated equally for the purpose of calculating mean percentages for each category. However, as detailed earlier, districts are far from equal in the number of permits they handle. This disparity would not be serious if districts had responded in similar ways to this question. However, districts had widely varying estimates. For example, for the first category of project value, very few districts gave an estimate close to the 46-percent figure used by IWR; many gave estimates of over 75 percent or under 20 percent. Compounding the problems of using this table, IWR divided the cost categories of the table into commercial, individual,and government permits, although the RIA data gave no basis for doing so. (See IWR pp. 161-166 and RIA.)
16. It is very difficult to follow the methodology IWR used in calculating opportunity costs. Evidently, estimates of the cost of modifications, the amount of yardage of fill denied by districts, and increased costs in placement of fill were factored into IWR calculations. Some IWR assumptions on these items are questionable. As discussed earlier, IWR assumed, without a justification given, that the cost of modifications equals the amount of benefits from technology transfer (see footnote 4). IWR estimated that an average of 4 million yd$^3$ of fill are requested annually by applicants in each district and that reductions of 33 percent of this figure are achieved by each district. The 33-percent figure, while higher than the average of estimates given by districts to OTA, is not unreasonable. However, the figure of 4 million yd$^3$ is extremely high. Of the nine districts giving figures to the OTA Corps survey of cubic yardage of fill requested and approved—in five cases, listing totals for 1980-82 year to date, and in at least one case, combining dredged with fill material—only one district estimated that as much as 4 million yd$^3$ was requested. The average amount requested per district was 1.5 million yd$^3$. Rather than eliminating 1.32 million yd$^3$, as can be derived from the IWR figures (33 percent of 4 million), all but one of the districts giving yardage figures estimated that they removed 500,000 yd$^3$ or less. This indicates that IWR estimates of opportunity costs may be high.

## Chapter 8

# Limitations of the 404 Program for Protecting Wetlands

# Contents

*Page*

**Chapter Summary** .......... **167**

**Introduction** .......... **167**

**Scope of Coverage** .......... **168**
Unregulated Activities .......... 168
Exempted Activities .......... 170
Nationwide Permits .......... 171
General Permits .......... 173
Cumulative Impacts .......... 174
Decisionmaking Criteria .......... 174

**Corps Performance** .......... **175**
Regulatory Policies .......... 175
District Implementation .......... 176
Monitoring and Enforcement .......... 177

**Chapter 8 References** .......... **182**

## Chapter 8

# Limitations of the 404 Program for Protecting Wetlands

## CHAPTER SUMMARY

There are fundamental differences in the way Federal agencies and various special interest groups interpret the intent of section 404 of the Clean Water Act (CWA). The U.S. Army Corps of Engineers views its primary function in carrying out the law as protecting the quality of *water*. Although wetland values are considered in project reviews, the Corps does not feel that section 404 was designed specifically to protect wetlands. In contrast, the Fish and Wildlife Service (FWS), the Environmental Protection Agency (EPA), the National Marine Fisheries Service (NMFS), and environmental groups contend that the mandate of CWA obliges the Corps to protect the integrity of *wetlands,* including their habitat values.

In terms of comprehensive wetland management, 404 has major limitations. First, in accordance with CWA, the 404 program regulates only the discharge of dredged or fill material onto wetlands. Projects involving excavation, drainage, clearing, and flooding of wetlands are not explicitly covered by section 404 and not usually regulated by the Corps. Yet such activities were responsible for the vast majority of inland wetland conversions between the mid-1950's and the mid-1970's. Rarely have these activities been halted or slowed because of Federal, State, or local wetland regulations.

Second, the Corps does not have adequate resources to regulate activities effectively in "all waters of the United States." Instead, the Corps uses "general" (or nationwide) permits for isolated waters and headwater areas. Because there are few application or reporting requirements for activities within areas covered by general permits, the Corps has limited regulatory control over the use of wetlands covered by general permits.

Third, several administrative problems presently limit the program's effectiveness. These problems include significant variations in the way different districts implement the 404 program, the lack of coordination between some districts and other Federal and State agencies, inadequate public awareness efforts, and the low priority given monitoring and enforcement.

Finally, Federal water projects planned and authorized by Congress prior to environmental protection policies of the last dozen years are generally not considered to pose a significant threat to wetlands, even though they may be exempted from 404 requirements. However, projects authorized 10 to 15 years ago that are now being undertaken often cause significant impacts to wetlands.

## INTRODUCTION

There is widespread agreement that the 404 program has major limitations in terms of providing comprehensive wetland protection. As stated by William R. Gianelli, Assistant Secretary of the Army (Civil Works), before the House Committee on Merchant Marine and Fisheries on section 404 of CWA, August 10, 1982:

> It is important to point out that wetlands subject to section 404 can be destroyed in a number of ways without any requirement for a Corps permit. They can be destroyed by excavating, draining, flooding, clearing, or even shading without the need for a Corps permit as long as those activities do not include the discharge of dredged or fill ma-

terial. So, it is clear that section 404 does not serve as the Nation's comprehensive wetlands protection law.

This chapter addresses these and other limitations of the program under two parts: "Scope of Coverage" and "Corps Performance." The first part discusses activities that may adversely impact wetlands and areas that are not addressed by section 404 because of either legislative or regulatory language. The second part discusses the implementation of section 404 by the Corps, including regulatory policies, district implementation, and monitoring and enforcement.

Sources of information for this chapter include OTA surveys of States and Corps districts as well as information provided in OTA's regional case studies and OTA interviews. The analysis of coverage of the program was prepared by reviewing the language of the legislation and regulations and considering the evaluations provided by these various information sources. The analysis of Corps performance, however, was limited by a lack of quantitative data.

# SCOPE OF COVERAGE

With respect to comprehensive wetlands protection, a number of gaps exist in the 404 program's geographical coverage of wetlands, types of development activities on wetlands that require permits, and the standards for determining if a permit will be granted. Resource agencies also contend that gaps have been widened by recent regulatory changes in the 404 program that were made in response to the regulatory reform initiatives of the administration. Because of inadequate data on the 404 permitting process prior to 1982, it is impossible to quantitatively document any changes in the quality of decisions about wetlands use in terms of environmental protection due to these administrative changes.

## *Unregulated Activities*

Several development activities that cause direct wetland conversions or significant impacts on wetlands but do not involve the disposal of dredged or fill material on wetlands are not included in section 404 and thus not regulated by the Corps. They include drainage of wetlands, dredging and excavation of wetlands, lowering of ground water levels, flooding of wetlands, deposition of material other than dredged or fill, removal of wetland vegetation, and activities on nonwetland areas.

### Drainage of Wetlands

Removal of water from wetlands through drainage ditches, tiles, and canals is the primary source of wetland conversion in some parts of the country, such as south Florida (1), prairie potholes (2), North Carolina (9). Drainage of wetlands is not covered under the existing 404 program unless the material removed from the ditches or canals is deposited back in the wetland area. Reasons for drainage include: bringing new areas into agricultural production or improving productivity on existing agricultural land (e.g., prairie potholes (2), Nebraska (4), Florida (1), North Carolina (9), South Carolina (9)); allowing harvest and reforestation of timber stands (which generally requires only partial drainage during critical time periods, e.g., North Carolina (9)); providing sites that can be developed for urban or industrial use (e.g., Florida (1)); and enhancing the use of areas for nonwetland purposes such as lawns (e.g., Washington State (10)).

### Dredging and Excavation of Wetlands

While dredged or fill material may not be placed on a wetland covered by the 404 program without a permit or exemption, wetlands themselves may be dredged or excavated without a permit as long as the resulting dredged material is disposed of on a nonwetland site. The wetland area may be excavated to provide a source of fill, to provide greater storage area for drainage of other wetland areas, or to create reuse pits or dugouts to store water and improve irrigation efficiency (e.g., Florida (1), Nebraska (4)).

### Lowering Ground Water Levels

Reducing the supply of water to wetlands through pumping is not covered under 404. This is an important activity for irrigation of cropland in some regions, such as the Central Platte River Valley and the Sandhills of Nebraska (4). It also may impact wetlands in a few isolated locations, such as the California desert, where limited water supplies are in demand for mining, agriculture, and ranching (3). Pumping to drain wetlands is also a technique that has been used in conjunction with excavation and fill projects by developers to improve the quality of a site prior to construction (1).

### Flooding of Wetlands

Flooding wetlands or creating reuse pits for irrigation is not covered under the 404 program. These practices, which occur in places like the prairie-pothole region (2) and the Rainwater Basin in Nebraska (4), may significantly change the character of a wetland and alter its habitat values. Flooding of wetlands involving construction of an impoundment most likely would involve the discharge of fill material and would require 404 review unless the project was exempted from coverage for some other reason, such as exemption for farm ponds, nationwide permit for headwaters, and exempted Federal construction projects.

### Deposition of Material Other Than Dredged and Fill Material

The Corps regulates the discharge of fill material if "the primary purpose is to replace an aquatic area with dry land or change the bottom elevation of a water body."[1] The Corps' authority to regulate the disposal of waste materials, such as wood waste, construction rubble, and household garbage in wetlands is not clear. The Corps has asserted that these materials should be regulated by EPA under section 402 of CWA because the primary purpose of the activity is to dispose of waste. EPA contends that the Corps should regulate these activities under section 404. This controversy, which is apparently close to resolution, has been an issue in cases involving disposal of logging slash and expansion of landfills into wetlands.

### Removal of Wetland Vegetation

Activities resulting in a gradual transition of an area to nonwetland can take place without 404 review in most regions of the country. For example, during the dry season in western Broward County, Florida, sawgrass has been mowed and chopped into the soil (1). Grass seed and fertilizer are then spread by aerial application. When the sawgrass sends up new shoots, cattle are introduced. Since they feed on the sawgrass preferentially, the seeded grass becomes the dominant species. The area is then no longer a wetland as defined by the Corps, and jurisdiction is lost for regulating development. In other circumstances, removal of vegetation involving the incidental discharge of dredged or fill material from activities with the purpose of bringing an area into a new use may require a permit under section 404(F)(2).

### Activities on Nonwetland Areas

Activities on nonwetland areas also can injure wetlands. For example, in the Platte River Valley and the Sandhills, land-use changes from ranching to irrigated cropland result in seasonal and long-term ground water drawdown and the subsequent conversion of wetlands. Upstream withdrawals of surface water can have adverse impacts on downstream wetlands. Diversions for irrigation and other uses, especially when accompanied by impoundments, reduce peak and average annual flows, which are important for maintaining some wetlands, such as the wet meadows along the Platte River in Nebraska (4). Erosion from land-disturbing activities and runoff containing pesticides and herbicides used on agricultural land can all impact wetlands.

These development activities cannot be viewed in isolation from other gaps in the 404 program for providing wetland protection. A development activity not involving disposal of dredged or fill material in a wetland may take place above the headwaters or be part of an existing farming operation and therefore be excluded from individual permit review under the nationwide general permit or be exempted from 404 jurisdiction entirely under 404 (F)(1). These exemptions are discussed below.

---

[1] 33 CFR 323.2 (m).

## *Exempted Activities*

Some development activities are exempted specifically by CWA from coverage by the Corps: *normal* farming, silviculture, and ranching activities such as plowing, seeding, cultivating, minor drainage, harvesting for the production of food, fiber, and forest products, or upland soil and water conservation practices; maintenance of "currently serviceable" structures such as dikes, dams, levees, and transportation structures; construction or maintenance of farm or stock ponds or irrigation ditches, or the maintenance of drainage ditches; and construction or maintenance of farm roads, forest roads, or temporary roads for moving mining equipment where such roads are constructed and maintained in accordance with best management practices (BMPs).[2]

According to Edward Thompson, Jr. (11), "Congress clarified its original intention to exclude *routine* earth-moving activities of agriculture, forestry, and related industries . . . from case-by-case review under section 404, with the understanding that their water-quality effects will be controlled by the States through the prescription of BMPs, under section 208 of the act." However, during the congressional deliberations on this point, Senator Muskie explained, "It is not expected that section 208(b)(4)(c) exemptions (from sec. 404) will be available for whole classes of activity, such as silviculture (i.e., forestry)." Activities would have to be "appropriate" for BMP regulation. Congress decreed under section 404(f)(1)(E) that farm, forest, and mining roads required BMP control apart from many other exempted activities, such as constructing irrigation ditches.

### Normal Farming, Silviculture, and Ranching Activities

Some routine or normal activities,[*] can lead to wetland conversion or deterioration. Agricultural activities were identified by the National Wetland Trends Study (NWTS) as being responsible for about 80 percent of the conversions of inland wetlands from the mid-1950's to the mid-1970's; case study information indicated that normal farming activities were responsible for some of these conversions. For example, in the Central Valley of California, many farming practices actually contribute to the maintenance of some wetlands (3). Changes in these farming practices may impact wetlands. For example, rice cultivation provides a major source of water to wetlands. Conversion of the land to other crops, such as orchards, could eliminate this water source and alter timing of water availability. More efficient farming practices, such as land-leveling techniques and herbicide use, can reduce wetlands acreage and available food for waterfowl.

Normal agricultural activities may also lead to wetland conversions and to other adverse impacts on remaining wetland areas. For example, in the prairie-pothole region, changes in farming methods, increased specialization in crop production, decreased number of farms with livestock, and increasing machinery size were identified as major causes of wetland drainage. These changes in farming methods have decreased the relative value of

---

[2] Clean Water Act, sec. 404(f)(1).

[*] The definition of normal activities is ambiguous and, depending on its interpretation, may result in wetland conversions. The Corps regulations issued on July 22, 1982, state that "to fall under this exemption, activities . . . must be part of an established (i.e., ongoing) farming, silviculture, or ranching operation" (33 CFR 323.4 [a][1][i]). Many wetland areas in the Rainwater Basin of Nebraska and similar areas throughout the prairie-potholes region, for example, are periodically cultivated and farmed before they are more permanently drained. The regulations are not clear as to whether alteration of this sort (even if a discharge of fill material was involved) would come under the normal farming exemption. Another example of this ambiguity problem is whether clearing wooded ponds for aquaculture is an exempted activity.

Ambiguity in the term "normal" has been recognized by the forestry industry in at least two Corps districts. Local forestry associations are working with the Corps' Vicksburg and Wilmington districts and EPA to define normal silviculture activities and to clarify which practices require review under section 404. Forestry practices of concern include conversions of mixed bottom land hardwood stands to hardwood plantations and conversions of pocosins to pine plantations wetlands as a source of forage and have increased soil erosion, which gradually causes filling of the wetland, decreasing its wildlife value. The increase in machinery size simultaneously has provided the horsepower to perform much of the drainage activity and increased the nuisance of farming around potholes (2).

### Farm Ponds/Irrigation Ditches/ Drainage Ditches

The farm pond exemption is of potential concern, given the freshwater wetland acreage that has been converted to open water, as shown by NWTS. OTA's New England case study (15) cites more detailed analysis of wetland change in 15 Massachusetts towns and notes that impoundments are the most important single cause of man-induced wetland change in inland areas (48 percent). Agriculture-related pond construction on existing wetland sites may be related to the transition of shallow to deepwater wetlands. The New England study further notes that although many of the impoundments are farm ponds, others, probably increasingly, are recreational ponds. This exemption is also of concern in regions (e.g., Playa Lakes and Nebraska) where the creation of irrigation reuse pits has resulted in wetland conversions or a transition to deeper water habitats.

### Construction of Farm, Forest, or Temporary Mining Roads

These activities are probably not a major cause of wetland conversion, provided BMP's are actually implemented. In the past, road construction was a major factor responsible for wetland conversions in some parts of the country, and today it continues to encourage wetland conversions indirectly. For instance, exempted logging roads built through wooded coastal swamps near river channels have provided access to areas that were then illegally filled for housing. Road construction may result in wetland drainage by roadside ditches. Also, road construction in or near wetlands often increases pressures for further urbanization and commercial development.

### Federal Construction

Federal construction projects specifically authorized by Congress and entirely planned, financed, and constructed by a Federal agency are also exempted from 404 permitting requirements. However, before such an exemption may apply, the Federal agency involved must prepare an adequate environmental impact statement (EIS) and make it available for congressional review prior to authorization or appropriation of funds. That EIS must consider the impact of the project in light of the section 404(b) guidelines that embody the principal 404 permit standards (404(r)). The exemption for Federal construction, which includes congressionally authorized Federal water projects, is not considered to be a significant threat to wetlands because the requirements of the National Environmental Policy Act (NEPA) must still be met.

Other Federal water projects that are not specifically authorized by Congress, such as the Department of Agriculture's (USDA) small-scale Soil Conservation Service (SCS) watershed projects, still require section 404 permits, compliance with principles and standards of NEPA, and compliance with agency policies on wetlands stemming primarily from Executive Order 11990. In general, these projects are considered to have less impact on wetlands now than they did in the past, owing to all of these environmental protection policies. However, there are many projects, authorized prior to the development of environmental protection policies but now under construction, that are a source of frustration for resource-protection agencies.

Flood control and drainage projects of the Corps that are not specifically authorized by Congress do not require 404 permits; however, the public interest review is still required. These projects may result in the conversion of some wetlands (e.g., fill of bottom land hardwoods); however, the rates of conversion are much less than they were prior to the public interest review.

## *Nationwide Permits*

Activities in some wetland areas are covered by nationwide permits, thus eliminating the necessity for individual permit review. Discharges of dredged or fill material in these areas may occur without the need for specific authorization from the Corps. Before the 1982 changes, these areas included:

- wetlands adjacent to nontidal rivers and streams located above the headwaters (headwaters being defined as less than 5 cubic feet per second (ft$^3$/s) average annual flow);
- natural lakes and adjacent wetlands under 10 acres that are not part of a surface or river stream, or fed by a river or stream above headwaters; and
- isolated wetlands not part of a surface tributary system to interstate or navigable waters.

The 1982 changes (9) broadened these permits to encompass all isolated wetlands (removing) the 10-acre limit. Several States, opposed to nationwide permits, have denied 401 certification for certain permits. In its May 12, 1983, proposed regulatory changes,[3] the Corps reinstated the 10-acre limit.

Nationwide permits have been criticized on various grounds. First, some sources claim that the Corps has no authority to exempt *areas*, as opposed to *activities*, from coverage; some States have sued the Corps on these grounds.

Second, discharges of dredged and fill material under nationwide permits are supposed to meet the following criteria: they cannot threaten endangered species or be discharged into a component of a State or National Wild and Scenic River System; they must be free of more than trace amounts of toxic pollutants; and fills must be maintained to prevent erosion and other nonpoint sources of pollution.[4] Discretionary authority, regional conditioning, and other measures also improve permit effectiveness. However, various parties contend that nationwide permits prevent the 404 program from stopping or mitigating destruction of much wetland acreage (9). Because there is little monitoring of activities for compliance, neither point of view could be verified with documented evidence.

Third, the Corps does not regulate activities occurring in headwater areas when waterflow is less than 5 ft$^3$/s, a standard that has been criticized as being inexact and injurious to wetlands, especially in areas of seasonal rainfall and in areas with low relief (e.g., Atlantic coastal plain). Higher relief areas subject to intense development pressure (e.g., the lowland creeks of western Washington) are also of concern with respect to the 5-ft$^3$/s standard.

In areas with seasonal rainfall, wetlands may or may not be covered by individual permits, depending on whether mean or median flow is used to define the 5-ft$^3$/s boundary. Also, in areas with low relief, the 5-ft$^3$/s boundary is difficult to determine and can be changed artificially by diverting streamflows in areas with an existing network of drainage canals.

Corps policies for determining the 5-ft$^3$/s boundaries vary among districts, depending on the availability of hydrologic information. More detailed information provided by applicants has been used to change a jurisdictional determination made by the Corps in at least one case in California (3).

Activities taking place in wetlands upstream of the 5-ft$^3$/s limit for individual permit jurisdiction that might impact wetlands include, among others, depositing fill for a variety of reasons, including urban development, instream dredging, peat mining, and agricultural conversions. Also, such upstream activities may reduce flows downstream so that the 5-ft$^3$/s boundary moves progressively downstream, exposing new areas to coverage under nationwide permits.

Finally, some isolated wetlands are only covered by a nationwide permit. According to the OTA case studies, isolated wetland types that experience controversial regulation under the nationwide permit include vernal pools, isolated mountain wetlands, pocket marshes, and closed basins (including diked areas) in California (3); pocosins and bays of North and South Carolina (9); swamps of southern New Jersey (6); and wetlands of the prairie-pothole region (2); and Nebraska (4).

Regulations allow the district engineer discretionary authority to require individual permits in areas covered under nationwide permits. This authority has been used in a few cases. For example, at the request of FWS and after discussions with the local governments, wildlife agencies, conservation groups, and others, the Los Angeles District of the Corps agreed to accept discretionary authority for the vernal pools of San Diego County because of the presence of endangered species (3). It must be noted, however, that individual permit review does not always result in the preservation of the wetland. In the San Diego case just mentioned, the individual permit process under the Corps' discretionary authority has not preserved as many pools as the city expected. In another case, the New York District considered using discretionary authority to regulate a planned-unit development project next to a national wildlife refuge. The threat of section 404 requirements prompted the developers to avoid the wetlands (6).

---

[3] *Federal Register*, vol. 48, No. 93, pp. 21, 466-21, 476.

[4] Clean Water Act, 323.4-2(b)(1-4).

## *General Permits*

Some development activities are given *limited* coverage by regulations in the form of general permits, which are developed within each district and may apply to all or part of the district. (General permits that apply to all districts are called nationwide permits.) Most general permits are for activities that cause little or no impact on wetland areas (e.g., mooring buoys) and do not require individual project permits. While some general permits provide some protection to wetlands, through the use of BMPs, the lack of monitoring of permit conditions means that many such activities may have greater impacts than officially allowed.

Some districts provide greater protection to wetlands than do other districts through language in their general permits designed to protect wetlands. For example, Wilmington District general permits for discharges into diked disposal areas; maintenance and repair of private bulkheads; and maintenance, repair, construction, or use of boat ramps all include language for the specific protection of vegetated wetlands. General permits for similar activities in the Charleston District do not include such explicit language for avoiding vegetated wetlands (9).

Criticisms of general permits include:

- the general-permit process eliminates both the normal public interest review and the opportunity for other agencies to comment on a project-by-project basis;
- public notice is not required, which eliminates a means for informing State and local agencies of activities that may require non-Federal permits;
- general permits may lead to cumulative conversion of wetland habitat to small-scale development; and
- general permits are not closely monitored to ensure that BMPs are followed.

Since there are no reporting requirements for most general permits, many projects covered by a general permit can be undertaken without checking with the Corps. If someone reports a suspected violation, the Corps will investigate and determine if an individual permit is necessary. To avoid potential violations, letters of authorization for specific projects can be obtained from the Corps. In fact, some communities in New Jersey, for example, require such a letter from the Corps before local approvals are obtained for construction.

General permits can reduce regulatory requirements for both applicants and the Corps. The most frequently noted successful use of the general permit was in reducing regulatory overlap between the requirements of the North Carolina Coastal Area Management Act and the Wilmington District. This general permit has broad support by applicants, the Corps, and other resource agencies. The permit covered 80 percent of all major projects in 1981 and still involves review by the NMFS, FWS, and the Corps (9).

Current efforts to grant general permits for State programs that do not have as stringent or encompassing review requirements as the Corps program are being met with resistance. Also, EPA has been reluctant to agree to general permits that would allow disposal of fill material in wetlands covered by special area management plans, such as the one developed for Grays Harbor, Washington (10).

General permits have been adopted in some cases that explicitly allow fill in wetlands. For example, the Wilmington District has a general permit for vegetative fill in wetlands from selective snagging operations by the Government. Exceptions include endangered or threatened species habitat, structures in the National Register of Historic Places, and National Wild and Scenic Rivers. The Wilmington District also currently is working to develop a general permit for the discharge of dredged and fill materials for drainage systems and for land clearing to convert lands to agricultural use. Stringent conditions (yet to be developed) would have to be met, and probably would meet all conditions. However, such an effort could potentially prevent the extensive delays and costs associated with the permit process for large agribusiness operations (9).

## *Cumulative Impacts*

Generally, permits are not denied unless substantial individual impacts can be shown; the combination or cumulation of minor impacts of many small projects is extremely difficult to evaluate in making permit decisions. It is difficult to deny a project for reasons of cumulative impacts alone, especially if it is in an area where similar projects already have been approved. These cumulative impacts are overlooked in many districts.

No clear nationwide guidance exists on how, where, and when to deny applications, and there is no legal basis for denying permits based on cumulative impacts of possible future projects. Most Corps districts try to minimize the impacts of specific projects. The result appears to be an incremental conversion of wetlands, without projections of cumulative impacts based on good scientific studies that entail adequate field investigations.

## *Decisionmaking Criteria*

Corps regulations state that the unnecessary alteration or destruction of important wetlands should be discouraged as contrary to the public interest.[5] The regulations state that no permit will be granted that involves the alteration of important wetlands unless the district engineer concludes that the benefits of the proposed alteration outweigh the damage to the wetlands resource. This guidance is considered by some to be inadequate and leads to variability in the degree of protection provided to wetlands.

Although the water dependency test (described on p. 2 of ch. 3) is considered to be well implemented in tidal wetlands, decisions based on the test are controversial for projects where permits are awarded for nonwater-dependent projects on the basis of no practicable alternatives. For example, the New York District recently granted a permit for townhouses in a wetland area in the Passaic River Basin (3). Under the permit, 8 wetland acres will be converted, while 15 manmade wetland acres will be required as compensation. Before this was agreed to, the New York Corps of Engineers required the applicant to study all possible alternative sites of a similar size within 5 miles of the proposed project. (Alternative sites do not need to be on property owned by the applicant.) For various reasons, the applicant ruled out all alternative sites. The Corps agreed after conducting its own verification process. The reasons cited were unfavorable zoning, inability to market the expensive townhouses, sewer bans, unavailability of the land, and large incremental developmental costs. Another district engineer could have used a different standard to define what was practicable. Lack of guidance on applying the practicable alternatives test was also noted as a problem when evaluating agricultural conversions of bottom land hardwoods by the New Orleans District.

In its proposed changes to the existing regulations published on May 12, 1983,[6] the Corps stated its desire to include property ownership as a factor in its decisionmaking process. As stated in the *Federal Register,*

> Section 320.4(a)(1): "Considerations of property ownership" would be explicitly expressed as a factor of the public interest. This has always been a basic tenet of Corps policy and has been implicit in previous regulations. The statement that "No permit will be granted unless its issuance is found to be in the public interest," would be changed to "A permit will be granted unless its issuance is found to be contrary to the public interest." The intent of this change is to recognize that within the context of the public interest review, an applicant's proposal is presumed to be acceptable unless demonstrated by the Government not to be.

This provision in essence would shift the burden of proof from the applicant to the Federal Government.

---

[5] Clean Water Act, sec. 320.4(b)(1).

[6] *Federal Register,* vol. 48, No. 93, op. cit.

# CORPS PERFORMANCE

As described elsewhere in this report, the 404 program has protected wetlands in many areas. Evaluations of the performance of different Corps districts by sources consulted by OTA varied greatly, however. Some districts were singled out by States for being outstanding in their implementation of the program, while some others were consistently criticized, especially for lack of action.* This lack of action may be a result of unclear regulatory policies and guidance established by the Corps leadership in Washington, D.C., or ineffective implementation of policies at the district level. Monitoring and enforcement also are important because no regulatory program can be effective without adequate monitoring of compliance with regulations and enforcement of sanctions against violators.

## *Regulatory Policies*

Three major aspects of Corps policy are criticized with respect to the degree of protection provided to wetlands under the 404 program: interpretation of the intent of section 404, interpretation of interstate commerce, and jurisdiction over incidental discharges related to clearing and excavation.

### Interpretation of the Intent of Section 404

The extent to which section 404 can be used to protect biological systems is at the heart of the controversy over the Corps interpretation of water quality. The objective of CWA is to protect the chemical, physical, and biological integrity of the Nation's waters.[7] The interpretation of biological integrity is the major issue. Broad interpretation of the concept of biological integrity and the objective of CWA would include protection of wetland habitat values. Federal resource agencies and environmental groups believe that the mandate of CWA obliges the Corps to protect the integrity of *wetlands*, including their habitat values, and not just the quality of the water.

The Corps, following a narrower interpretation of CWA, views its primary function in carrying out the law as protecting the quality of water; protecting other wetland values is a secondary concern. The Corps does, however, consider fish and wildlife habitat values under its general public interest review that is part of the overall balancing process used to determine whether to grant a permit. However, habitat values are not afforded any special status over other factors that are also considered in the public interest review except to the extent that Corps regulations state that the unnecessary alteration or destruction of important wetlands should be discouraged.

### Interpretation of Interstate Commerce

The Corps interpretation of the scope of interstate commerce issues that arise when a district engineer considers whether to use discretionary authority and to require individual permit review for an isolated wetland has been criticized as too restrictive. One source stated that the Corps leadership is pressing districts to apply section 404 only where interstate commerce issues, narrowly defined, are involved. In response, some districts are not considering impacts on migratory waterfowl from filling of inland wetlands and are only sparsely regulating such activity.* Other aspects of interstate commerce that are not considered but could provide greater opportunities for wetland protection under section 404 include water withdrawal for interstate industry, crop production, visitation by interstate and international visitors, mining and oil extraction (regardless of whether the activity is wetland-dependent), and land development for interstate purchases (3).

### Jurisdiction Over Incidental Discharges

In the past, the Corps has been generally reluctant to exert authority over land-clearing and excavation activities that involve discharges into wetlands from the drippings of dragline buckets, bulldozers, and the like, even though such jurisdiction has been authorized through court decisions (14).

---

*For example, "The C.O.E. (Corps) offers minimal protection to wetlands with the 404 Program. The degree of concern and quality of the 404 Program varies with each C.O.E. District Office. For example, the Omaha C.O.E. District appears not to be concerned about protecting anything, and runs an inefficient program; while the Salt Lake City Regional Unit of the Sacramento District Office is very active and concerned about all the activities" (Wyoming).

[7] Clean Water Act, sec. 101(a).

*California response to OTA's questionnaire.

### CLEARING

The Corps clarified its position on vegetation clearing in Regulatory Guidance Letter 82-11. The policy states that the removal of vegetation is not a discharge of dredged or fill material (except in the Western Judicial District of Louisiana). The placement of vegetative matter into waters of the United States requires a 404 permit if the "primary purpose" is "replacing an aquatic area with dry land or changing the bottom elevation of a water body."[8] Incidental soil movement related to the planting or removal of vegetation is not considered to be a discharge. However, if accompanied by land leveling that alters topographic features of "waters of the U.S." through significant soil movement, it is subject to section 404.

The variation in this policy for the Western Judicial District of Louisiana is a result of the court decision for *Avoyelle's Sportsmen's League* v. *Alexander*.[9] The court determined that the clearing of bottom land hardwood trees for agricultural use and the removal of their roots by plowing was held to be a discharge of dredged or fill material within the scope of regulation under section 404(f)(2). This section states that, if the discharge of the dredged or fill material is incidental to an activity (except those specifically exempted by sec. 404) designed to bring an area of water of the United States "into a use to which it was not previously subject, where the flow or circulation of navigable waters (waters of the United States) may be impaired or the reach of such waters be reduced," a section 404 permit is required. The U.S. Fifth Court of Appeals in New Orleans recently upheld the lower court ruling.

Prior to this decision by the appeals court, Corps leadership held that the district court decision would be adhered to only in the portions of the Corps districts that are within the Western Judicial District of Louisiana, where the lower court decision was made. The rationale for this position is that the judge's decision in the case was not a broad-based decision attacking the validity of section 404 regulations (as has been the case in other Federal district court decisions recognized nationally by the Corps), but that the Avoyelles Sportmen's League case was an action to force the Corps to regulate (under section 404) the specific activities occurring on the specific tract involved. Also part of the rationale is the idea that, in a similar situation, a judge in another Federal judicial district might decide differently.

Actual implementation of this vegetation-removal policy in the Western Judicial District of Louisiana is also being criticized. These criticisms relate to the issues discussed previously regarding the Corps' interpretation of water quality. Although 404 permits are required, they are generally being issued because significant incremental water quality degradation relative to existing levels cannot be adequately demonstrated (12).

### EXCAVATION

Drainage of wetlands by excavation can seldom be accomplished without directly or incidentally discharging dredged or fill material into the wetland area. However, the Corps rarely regulates drainage that occurs during the conversion of wetlands to agricultural or urban use.

## *District Implementation*

Because of the nature of the Corps' organization, there is a great deal of variability in the manner in which the 404 program is implemented among the semiautonomous districts. Of the 33 States that described weak inland wetland protection in response to OTA's questionnaire, 7 said that the 404 program is ineffective in providing additional coverage. Most of the problems were related to Corps resources and attitudes. Several States commented that some districts are hampered by lack of manpower and funding—for monitoring of violations, for instance. In many cases, only a few field personnel are available to cover large areas.*

The Corps would agree with this assessment of manpower/funding constraints. After the 1975 court decision requiring the Corps to expand its jurisdiction, the Corps requested additional funding and manpower. This request was denied by the Office of Management and Budget (OMB). Thus, the Corps had to reallocate resources to comply with the court order. According to some States, a few districts place a low value on wetland protection and are inactive by choice. For example, some districts favor a broad interpretation of nationwide and general permits and are reluctant to assert discretionary jurisdiction for individual permits.*

---

[8] 3 CFR, sec. 323.2(m).

[9] 473 F. Supp. 525 W.D.La., 1979.

*States commenting on Corps resources include Alaska, Vermont, and Wyoming.

The case studies revealed two major styles used by Corps districts to deal with objections to 404 permit applications. In some districts, the Corps plays an active role as mediator in disputes between applicants and resource agencies with wetland-protection concerns. Resource agencies are positive about this approach in districts where it is used. Although the process can be time-consuming, there is general agreement by the agencies that better decisions and better working relationships have resulted. In fact, one Corps regulatory chief commented to OTA that regulatory reform measures that limit the time available for this kind of decisionmaking may result in more permits being denied. Other districts suggested these time limits would result in more "rubber-stamp" approvals of permit applications.

In other districts, the Corps plays a more passive role in resolving the objections of resource agencies to permit applications. The applicants are directed to work out the objections of other agencies on their own. The Corps generally will approve the permit when differences are resolved. Two problems were noted in the case studies that can make this approach difficult. First, the applicant may be faced with conflicting recommendations from different agencies. For example, a compensation measure to enhance fish resources may conflict with one to enhance wildlife resources. These conflicts generally are resolved by negotiation and compromise between the agencies and project proponents before permits are issued; however, this does little to avoid frustration for applicants. The second problem is that of finalizing agreements that were made without the presence of the Corps, the major decisionmaker. The results of meetings between objecting agencies and permit applicants are often interpreted differently, especially if the decisionmaking agency is not present to verify compromises or changed permit conditions.

The OTA case studies also noted problems that reviewing agencies have had with the Corps. Inadequate information on public notices was noted with respect to at least one district. Incomplete or inaccurate information necessitates requests for additional information and prolongs the review process. Poor communication with review agencies, especially on unauthorized activities, was noted as a problem in two studies (3,6).

Finally, some States see Corps offices as making inadequate efforts to publicize the program.* Other districts are considered to have effective programs for public awareness. A well-publicized program can accomplish several things. First, it can help ensure that project proponents apply for necessary permits. Publicity on what will or will not be permitted under 404 can help ensure that projects submitted for review are designed so that the permit can be obtained readily. Some districts have cited a marked improvement in the quality of permit applications, noting that the majority of applicants no longer request filling coastal wetlands for non-water-dependent uses. In addition, increased publicity leads to better monitoring and enforcement, as discussed in more detail below.

## Monitoring and Enforcement

The Corps has authority under section 404 to monitor and enforce the conditions of its permits. But the 404 program has experienced many problems in monitoring permitted activities and enforcing permit conditions. Owing to inadequate funding and manpower, and in some cases, reflecting internal priorities, many districts cannot or do not effectively monitor the areas under their jurisdiction for violations. In particular, relatively few projects are field-checked in many districts for compliance with permit conditions after a permit is granted. The Corps authority to take action against unauthorized activities is also limited. Because EPA has greater enforcement authority to take action against unpermitted and therefore illegal discharges of dredged or fill material under sections 301, 308, and 309, the Corps is often forced to rely on EPA and the Justice Department for obtaining injunctions against illegal activities.

---

*Several States responding to the OTA survey made comments along these lines: "Permitting by the Corps of Engineers under section 404 has had no importance in the control of wetlands in the State of New Hampshire. The State program issues between 1,000 and 2,000 permits a year and has for the last 8 years. Federal permits in New Hampshire are currently running at a level of approximately 100 per year. One of the significant reasons for this difference is that the State permit program has no exemptions for any type of applicant (government agencies, agriculture, etc.), and has issued no general or statewide permits for any size projects. The 404 program administered by the Corps of Engineers lacks publicity in New Hampshire and eliminates half of the projects in New Hampshire by national permits" (New Hampshire). Also, "Freshwater wetlands in the coastal zone could be better protected by the Corps of Engineers than by the Coastal Council because of differences in authority, but the Corps uses the general permit to let all freshwater wetlands be filled unless the Coastal Council objects very strenuously" (South Carolina).

*"The Corps efforts to inform the public of permit requirements are also limited and haphazard" (Vermont).

### Compliance With the Program

Two basic types of violations of the 404 program occur: discharge of dredged or fill material without a permit and discharge in violation of conditions placed on permits. According to the Corps, 3,724 violations of sections 404 and 10/404 were reported or detected during fiscal year 1980 (13). This figure was not broken down by type of violation. OTA asked districts to estimate the number of violations detected annually involving: 1) permit conditions, and 2) discharging material without a permit. Though percentages varied greatly among districts, more than 80 percent of estimated violations overall were of the second category, unpermitted activities. Because there are no requirements to demonstrate that a project qualifies for permitting exemptions, the use of general and nationwide permits may contribute to this high percentage of violations from unpermitted activities.

It is difficult to establish the percentage *rate* of compliance from this information. If 20 percent of violations concerned violation of permit conditions and the figure given by the Corps is correct, then about 745 such violations took place in fiscal year 1980. In that year, 8,013 permits and letters of permission were issued, giving a compliance rate of roughly 91 percent. This rate is compatible with the estimates of the four districts reporting percentages of compliance to the OTA survey. The percentage of violations estimated ranged from 1 to 15 percent, with a mean of 8 percent, giving a compliance rate of 92 percent. The Corps Institute of Water Resources (IWR) report estimated that compliance with *general* permit conditions was 95 percent (5). The NMFS Southeast region found that of the 80 individual permits that were completed or under way (of 110 permits examined), at least 58, or 73 percent, complied with permit conditions recommended by NMFS. Rates of compliance for completed projects varied from 100 percent in two districts (Charleston, Savannah) to 36 percent in one district (Mobile) (7).

The degree of compliance also varies from year to year within each district. For example, although NMFS determined that in 1981 the Charleston District had achieved nearly 100-percent compliance with permit conditions, in 1982 NMFS did a similar analysis and discovered that applicants appeared to have disregarded permit conditions in 33 percent of the completed, permitted projects that were evaluated. On the other hand, according to the Corps, the percentage of those permitted projects in the Seattle District that deviated from what had been permitted declined from 15 percent in 1980 to 8 percent in 1981 and to 4 percent in 1982. This increase in compliance has been attributed to increased public awareness of the program and the knowledge that it is being implemented more consistently and completely.

It is not enough, however, to compare the results of such analyses to evaluate the performance of the different districts without knowing the nature of the conditions that are included in the permit. Some districts do not incorporate controversial conditions such as mitigation and compensation measures into the permit. Instead, agreements are made between the applicant and concerned agencies. The Corps does not evaluate whether the agreed-on mitigation has been implemented successfully (10).

Enforcing wetland regulations can be difficult. In some districts, the Corps sends teams to investigate suspected violations because of threats made to district personnel in wetland cases (4). The most frequent types of noncompliance found by one observer were as follows:

- Unpermitted activities: loose-fill projects (e.g., trash dumping), minor erosion-control projects (bulkheads, riprap), and construction of boat ramps and access roads. Major projects, such as marinas and canal dredging, were rarely undertaken without permits.
- Violations of permit conditions: failure to perform sedimentation control (e.g., revegetation,

turbidity screening), violation of size/dimension limits placed on structures, and placement of dredged and fill material.

Inland States experienced greater problems than coastal States, with more violations from dredging than from fill or construction projects; more violations took place with individual permits than corporate permits

## Extent of Monitoring

Districts differ in the amount of time and expense they devote to monitoring of permitted activities and enforcing of permit conditions. Some districts undertake site investigations of all permitted developments at least once during construction and again after completion of work, and they frequently survey their jurisdictions for unpermitted activities. Other districts are basically reactive in monitoring and enforcement: if a violation is reported to district personnel, it will be investigated; however, the district does not search for violations itself.

Corps districts were asked by the OTA survey to estimate the percentage of permits field-checked by Corps personnel and by personnel from other agencies to monitor compliance with permit conditions after a permit is granted. Estimates of the percentage checked by Corps personnel ranged from near 0 to 100 percent, with an average of 56 percent. About a third of the districts said that they check all permits. Several of these districts said that a much smaller percentage are checked in detail, however. Most major projects are checked periodically.

Of the 16 districts estimating the percentage of permits checked by other Federal agencies, estimates ranged from 1 to 80 percent. All but three districts estimated 10 percent or less with most estimates at 5 percent or below.[10]

Districts also were asked by the survey how and how often wetland areas are monitored for violations. Districts use combinations of aerial surveys and photography, autos, and boats. The frequency of inspections varies greatly with the district and the type of wetland concerned. Roughly a third of the districts do not have a specific program of monitoring. Instead, they rely on reports of suspected violations from citizens, organizations, and State and other Federal agencies. In addition, monitoring is done by Corps personnel in the course of performing other duties—e.g., during inspection of permitted projects for compliance. Personnel flying over an area for other reasons may also check to see if unpermitted development activities are occurring.

About a fifth of the districts indicated that they do not regularly monitor inland wetlands but do follow a monitoring schedule for wetlands located adjacent to coastal or major riverine waterways, the areas in which most development regulated by 404 occurs. Last, about half of the districts indicated that they monitor all the wetlands in their jurisdictions, often monitoring activities around coastal areas or major streams more frequently. Frequency of monitoring of the wetlands near major waterways by those districts with a monitoring program varies from daily to once every few years. Most districts monitor such areas several times a year. Those districts that regularly monitor inland wetlands usually do so on a yearly or multiyear cycle.

As mentioned above, districts rely heavily on non-Federal sources (private citizens, conservation groups, State agencies) to report violations. In fiscal year 1980, about 18 percent of all violations discovered by the Corps were first reported by private citizens and another 4 percent by environmental groups (13). When asked by the OTA survey to estimate the proportion of violations reported by private citizens and organizations, estimates by districts ranged from 5 percent to 95 percent, with a mean of 40 percent. With reductions in the budgets of State and Federal agencies, reliance on citizen input is likely to increase. Such reliance does not necessarily mean that districts are negligent in monitoring. Citizen involvement varies according to perceptions of wetlands and awareness of the 404 program. Different areas of the United States differ greatly in these respects.

One source found the most effective monitoring and enforcement efforts took place when State agencies and Corps districts cooperated closely. "By backstopping one another and by pooling resources, the agencies make up for each other's deficiencies and create a more vigorous enforcement posture that neither could establish alone (8).''

---

[10] EPA funding levels have enabled EPA personnel to review only a small percentage of permits (10 percent in 1979), from J. A. Zinn and C. Copeland, "Wetland Management," Congressional Research Service, CP1451, 1982, p. 95.

The OTA prairie-pothole case study (2), for example, presents two contrasting State responses to coordination with the Corps on monitoring and enforcement, which in part reflect these States' capabilities to control wetland use. In Minnesota, the State regional network of hydrologists and game wardens detects and reports potential 404 violations. The Minnesota Department of Natural Resources also sends the Corps notices of applications for State permits, which gives the Corps an opportunity to determine whether 404 permits are also required. North Dakota, however, has no regional network of State agencies for reporting potential violations, and North Dakota agencies do not inform the Corps of activities over which the State has jurisdiction and that the Corps may also have authority to regulate under section 404.

### Problems in Monitoring

Many districts devote most of their efforts to wetlands in the vicinity of historically navigable waters. While this is the area in which most permit applications originate and which has potentially the most serious violations, such attention has resulted, in some cases, in the lack of attention to permitted activities in inland areas. Inland wetlands that are only periodically innundated receive the least attention; in some cases, districts make little effort to verify whether the area is a wetland (4,8).*

The Corps in Nebraska has been challenged in at least one case on its determination about an area as a wetland. Upon reevaluation, the Omaha District concluded that the area in question was indeed a type I wetland, and 404 authorization was required, although the fill eventually was authorized under a nationwide permit.

Another State reported that, owing to the remoteness of the Corps offices, neither Corps nor FWS personnel cover a large portion of the State and therefore must depend on the State to supply information. ''The Corps does not know if compliance with section 404 and section 10 is high or low and is not attempting to increase compliance.'' Several States believe that Corps district resources are insufficient to carry out adequate monitoring efforts (e.g., Rhode Island, Tennessee). A few districts indicated that monitoring efforts have been curtailed as a result of budgetary cutbacks.

Another disincentive to conducting a vigorous monitoring of permitted activities is the knowledge that in most cases, the Justice Department is reluctant to prosecute violators, especially if permit violations only involve a few acres.

### Enforcement

When a permit violation is discovered, Corps districts have several options. A cease-and-desist order can be issued. For projects that have been initiated without going through the permitting process, negotiations with violators to accept modifications are common. If the project is deemed to be essentially in compliance with environmental guidelines and with minor impacts, it is often granted an after-the-fact permit. Last, the violator can be taken to court, the project dismantled, and fines imposed. Litigation is often favored in cases where permitholders egregiously violate the conditions of their permit. In less serious violations, the permitholder may be required to stop the activity in dispute and to provide mitigation of some sort.

Generally, every effort is made to resolve violations short of actual prosecution. In many cases, subsequent investigation determines that suspected violations are, in fact, legal activities—e.g., falling under a general permit or not requiring a 404 permit. The Corps estimated that in fiscal year 1980, 2,273 such cases occurred—61 percent of the number of violations listed. After-the-fact permits are also common: 872 in fiscal year 1980, or 23 percent of violations (13). In many districts, after-the-fact permits are far more common. Twelve districts reported on the OTA survey that over 60 percent of violations receive such permits, and five other districts said that ''most'' violations are permitted after the fact.

Finally, violators are not prosecuted if voluntary restoration is made, although restoration is often made under the threat of prosecution. Voluntary restoration or even offsite mitigation may be made in the context of after-the-fact permitting. For example, in a case in North Carolina, a developer already had cleared approximately 30 acres of bottom land hardwood swamp and partially erected a dam to build a lake before the violation was reported. In this instance, restoration was so difficult that the developers were open to any other alternative. To avoid litigation, and at the suggestion of the Wilmington District, the owner of the land purchased a previously unregulated 60-acre Carolina bay and deeded it to the Nature Conservancy. The Corps agreed to take no legal action and then granted an after-the-fact permit. The landowner could then claim a charitable contribution, and the Nature Conservancy purchased a priority site at less than one-third of its value. Although some lauded this creative resolution of the problem, others in both public agencies and private conservation groups said the penalty was not appropriate. They point out that no wooded swampland was restored, although 30 acres were converted. Replacement of one wetland type for another could set a precedent for the conversion of one wetland type with certain wildlife habitat values, while preserving another with different resource and habitat values (9).

---

*Response of Washington State to OTA questionnaire.

In many districts, most or all violators agree to voluntary restoration.* Some Corps districts may be more successful than others in obtaining voluntary restoration. One technique used by the Wilmington District is to coordinate closely with the U.S. Attorney's Office, which in turn sends a letter to the violator stating that a file has been opened on the case. Such measures add weight to the negotiations for voluntary restoration. In some cases, however, such agreements are not made in good faith by violators, and further action must be taken by districts.** In some districts, voluntary restoration takes place in less than a quarter of violations.

In the opinion of some observers, some Corps districts have been too ready to grant after-the-fact permits or dismiss violations in other ways and too sparing in instituting litigation against violators.***

The Corps has experienced significant problems in prosecuting violators. If violators do not respond to Corps orders to cease projects that violate 404 standards, districts may request U.S. district attorneys to prosecute. However, district attorneys are often reluctant to take on 404 cases, regarding them as being of lesser importance than other crimes and, as such, of low priority in the tens of thousands of cases that are handled each year by the Department of Justice. Corps districts file about 4 percent of violations with the Justice Department for prosecution. However, outside observers say that many additional cases are never forwarded, in the knowledge that prosecution, especially in small cases, is unlikely.*

Some cases referred to the U.S. Attorney are never resolved, for example, when there is insufficient evidence to convict. According to the Philadelphia District, personnel turnover is also a big problem in dealing with violations because new personnel may not be familiar enough with a violation to get it resolved.

Of the cases that are resolved through the U.S. Attorney, penalties may consist of fines, restoration, or some combination of the two. One case study revealed some variations in how penalties are handled in two Corps districts. In negotiated settlements, the Wilmington District generally resolves the violation with both fines and restoration. Fines are assessed based on past violation records and the degree to which restoration is possible. For example, after its fifth violation in 2 years, Texasgulf Co. voluntarily restored 6.5 acres in the Pamlico-Albermarle estuary at a cost of approximately $200,000 and paid a fine of $5,000. The Charleston District noted that it seldom requires fines. In both North Carolina and South Carolina, courts generally have been reluctant to impose fines. When the restoration is costly, courts believe that this alone constitutes an adequate penalty. Penalties and attorneys' fees are typically viewed as a cost of doing business, according to another case study, and restoration requirements are crucial to an effective program. If restoration is imposed, then the violator stands to gain nothing. Some districts are often reluctant to prosecute offenders. Because Corps personnel do not see themselves as policemen, the monitoring and enforcement aspects of the program are unattractive.

---

*As stated by one district, "The majority of our violations are resolved by granting after-the-fact permits. We have not prosecuted any violators. All violators to date have agreed to perform necessary restoration work without prosecution" (Albuquerque).

**As put by another district, "Of those (violators) who agree to restore, a large percentage really have no intention of restoring and will delay indefinitely if allowed to, which cumbersome legal procedures allow them to do (Little Rock).

***"The Corps seldom takes violators to court. Thus, there is little deterrent to noncompliance" (Vermont).

*One study concluded that "A major finding of the Urban Institute Study with respect to enforcement practice is that a substantial disjunction exists between detection of violations and effective legal followup. The record of administrative-prosecutorial cooperation revealed by our study is quite poor. While there are a few well-known cases of outstanding coordination between U.S. Attorneys and the Corps . . . U.S. Attorneys have not accepted wetlands cases as a major priority . . . many cases that can and should be prosecuted either fall between the cracks or are handled by default on an 'after-the-fact permit' basis." Rosenbaum (15).

However, personnel from several agencies and interest groups think that fines should be imposed in addition, because restoration often doesn't replace the original resource. They also think that fines should be large enough to serve as a deterrent.

Districts differ markedly in the number of cases they submit for litigation and in the results of prosecution. At least five districts said they did not submit any violations for prosecution in the 1980-82 period. A few districts said litigation produced good results.* More districts were frustrated by lack of action from the Justice Department, low fines or lack of restoration ordered by courts, or slowness in the legal process. As stated by one, "The legal system affords very low-priority service, and because of extensive delays and frustrations, we seek other solutions."

One technique is for the Corps to coordinate its enforcement efforts with those of a State program. For example, the Baltimore District reported in an interview with OTA that for cases in which voluntary restoration was not successful and after-the-fact permits not appropriate, the State could prosecute under the State wetlands law more readily than the Corps could obtain court assistance under section 404. Coordination with the State is enhanced with monthly enforcement conferences. State programs with administrative law judges, as in New York, are able to handle some 404 violations expeditiously.

However, State enforcement may also be problematic. The Philadelphia District had difficulties when New Jersey took the lead on enforcement because of slowness or reluctance by the State Attorney General. Florida is considered to be less equipped than the Federal Government to prosecute some wetland cases owing to the lack of experience of the State's legal staff and lack of funds to hire expert witnesses and to conduct site-specific fieldwork required to prepare solid professional opinions.

---

*"The results from prosecutions have been excellent. Consent decrees have obtained restoration on numerous cases and civil penalties from $500 to $10,000" (Norfolk).

# CHAPTER 8 REFERENCES

1. Center for Governmental Responsibility, "Wetlands Loss in South Florida and the Implementation of Section 404 of the 'Clean Water Act,'" University of Florida College of Law, contract study for OTA, September 1982.
2. Department of Agricultural Economics, "Wetlands in the Prairie Pothole Region of Minnesota, North Dakota, and South Dakota—Trends and Issues," North Dakota State University, contract study for OTA, August 1982.
3. ESA/Madrone, "Wetlands Policy Assessment: California Case Study," contract study for OTA, September 1982.
4. Great Plains Office of Policy Studies, "Wetland Trends and Protection Programs in Nebraska," University of Nebraska, contract study for OTA, September 1982.
5. Institute of Water Resources, *Impact Analysis of the Corps' Regulatory Program,* unpublished report, 1981, p. 215.
6. JACA Corp., "A Case Study of New Jersey Wetlands Trends and Factors Influencing Wetlands Use," contract study for OTA, September 1982.
7. Lindall, W. N., Jr., and Thayer, G. W., "Quantification of National Marine Fisheries Service Habitats Conservation Efforts in the Southeast Region of the United States," *Marine Fisheries Review,* vol. 44, No. 2, 1982, pp. 18-22.
8. Rosenbaum, Nelson, "Enforcing Wetlands Regulations," in *Wetland Functions and Values: The State of Our Understanding,* P. E. Greeson, J. R. Clark, and J. E. Clark (eds.), American Water Resources Conservation, Minneapolis, Minn., 1979, pp. 44-49.

9. School of Forestry and Environmental Studies, "Wetland Trends and Policies in North and South Carolina," Duke University, contract study for OTA, August 1982.
10. Shapiro & Associates, Inc., "An Analysis of Wetland Regulation and the Corps of Engineers Section 404 Program in Western Washington," contract study for OTA, September 1982.
11. Thompson, E., Jr., "Section 404 of the Federal Water Pollution Control Act Amendments of 1977: Hydrologic Modification, Wetlands Protection and the Physical Integrity of the Nation's Waters," *Harvard Environmental Law Review*, vol. 2, 1977, pp. 264-287.
12. U.S. Army Corps of Engineers, Regulatory Branch, personal communication.
13. Corps of Engineers, Regulatory Board, FY 1980 Regulatory Summary Report.
14. *U.S.* v. *Holland,* 373 F. Supp. 665 (M.D. Fla. 1974), *U.S.* v. *Fleming Plantations,* 12 E.R.C. 1705 (E.D. La. 1978), *Weiszman* v. *Corps of Engineers,* 526 F. 2d 1302. 1306 (5th Cir. 1976), and *Avoyelles Sportsmen's League* v. *Alexander,* 473 F. Supp. 525 (W.D. La. 1979).
15. Water Resources Research Center, "Regional Assessment of Wetlands Regulation Programs in New England," University of Massachusetts, contract study for OTA, September 1982.

# Chapter 9

# Capabilities of the States in Managing the Use of Wetlands

Photo credit: OTA staff, Joan Ham

# Contents

Page

**Chapter Summary** .......... **187**

**General State Wetland Capabilities** .......... **187**

**Overlapping of State/Federal Wetland Regulatory Programs** .......... **189**
Activities and Areas .......... 189
Implementation Procedures .......... 192

**State-Program Implementation Problems** .......... **193**
Funding .......... 193
General Attitudes Toward Wetlands .......... 193
Monitoring and Enforcement .......... 194
Inadequate Technical Information and Expertise .......... 194
Agency Fragmentation .......... 195
State Interest in Assuming 404 Permitting .......... 195

**Chapter 9 References** .......... **195**

TABLES

*Table No.* *Page*
25. Values Protected by State Wetlands Regulatory Programs in New England .......... 190
26. Exemptions by State Wetland Regulatory Programs in New England .......... 190

## Chapter 9

# Capabilities of the States in Managing the Use of Wetlands

## CHAPTER SUMMARY

Almost all 30 coastal States (including those bordering the Great Lakes) have programs that directly or indirectly regulate the use of their coastal wetlands. These programs often rely on Federal funding from the Department of Commerce's Office of Ocean and Coastal Resource Management (OCRM). Only a few inland States have specific wetland programs. Through a combination of the program to enforce section 404 of the Clean Water Act (CWA) and State programs, most coastal wetlands are regulated reasonably well; inland wetlands generally are not regulated by the States.

Representatives from most States with wetland programs feel that State and Federal programs complement one another. Corps districts often let State agencies take the lead in protecting wetlands, using the 404 program to support their efforts. Other States rely on Federal programs, State influence on Federal programs, local regulation, and State programs that may indirectly affect the use of wetlands in the course of performing other primary functions.

States can assume the legal responsibility for administering that portion of the 404 program that does not cover traditionally navigable waters if certain Environmental Protection Agency (EPA) requirements are met. Twelve States have evaluated or are evaluating this possibility, and four are administering pilot programs to gain practical experience prior to possible program assumption. In general, most States have neither the capability nor the desire to assume sole responsibility for regulating wetland use without additional resources from the Federal Government; some States would be reluctant to do so even with resources.

## GENERAL STATE WETLAND CAPABILITIES

States may assume the legal responsibility for administering portions of the 404 program if certain requirements established by EPA are met. The administration and the leadership of the U.S. Army Corps of Engineers have also stressed the desirability of transferring a large proportion of the responsibility for regulating the use of wetlands to the States. This could be done by decreasing the area regulated by the Corps to historically navigable waters, thereby de facto increasing the State role; increasing funding for State regulatory programs; granting additional powers to States to regulate broad areas under general permits without formal assumption of the 404 program; and easing the standards for such assumption.

During the course of this study, OTA examined the capabilities of the States in managing the use of wetlands. Although a thorough review of the capabilities of individual States was beyond the scope of this study, OTA did examine many State programs through a State survey, to which 48 States responded, and 10 regional case studies, which commented on 21 State programs.

Of all 30 coastal States (including States bordering the Great Lakes), the majority claimed high State coverage of *coastal wetlands*. About 20 indicated that their programs are more dominant than the 404 program in their State; half of these States said the 404 program was completely redundant.

Other coastal States indicated that 404 plays an important role in protecting coastal wetlands.

The coverage of *inland wetlands* by coastal States is varied: 17 coastal States indicated that their inland wetlands are not well protected by State programs; 7 indicated that they provide protection for most such wetlands. For the 20 inland States, programs provide little coverage to wetlands outside of small areas under direct State management. Isolated wetlands generally are not well regulated in most States.

Even for States with wetland regulatory programs, there may be gaps in wetlands coverage. State programs often exempt some activities from permitting requirements, such as agriculture, mosquito control, public utility projects, and actions of local government (8). Florida provides a good example of a State that does not regulate some of the activities that threaten wetlands the most. Although the Florida dredge-and-fill laws do not regulate drainage activities, the South Florida Water Management District does have some control over drainage activities by requiring permits for the construction and operation of surface water management systems. However, exemptions are provided for agricultural and silvicultural activities. Drainage of lands for agriculture is often the first step in destroying wetlands that are used eventually for urban development (1).

Some State laws encourage the conversion of wetlands. In particular, some drainage programs are carried out by State agencies and some private drainage is subsidized (by Kentucky, Ohio, and Nebraska). For example, although State law in Nebraska charges one agency to protect wildlife habitats and another to protect water quality, a third agency is required by law to plan for draining wetlands and county boards are required to drain areas upon petition by owners. The 1975 Nebraska Groundwater Management Act also states that all irrigation runoff must be retained on the irrigator's property. This stipulation has increased the use of dugouts and reuse pits in the Rainwater Basin, leading to wetland flooding and creating opportunities for wetland drainage (6).

Expenditures and staffing for wetland-related State regulatory activities are highly variable. Agency personnel with wetland responsibilities often carry out other duties as well, although personnel from other agencies may assist in monitoring wetland areas for unpermitted activities in the course of other work. Asked by the OTA survey to list numbers and types of personnel and budgetary allocations devoted to State wetland-protection efforts, most States listed programs and budgets without breaking out wetland-related components. The number of employees working part time or full time on wetland matters ranged from 1 to over 20. Of States listing budgets that can be traced to wetlands, figures range from $12,000 to over $100,000 in 10 States. Six States indicated almost no staffing and budget allocations for wetland management.

Most States do not have permitting programs solely concerned with wetlands. Instead, they rely on Federal programs, State influence on some Federal programs, State wetland-acquisition programs, and other State programs that incidentally cover some development activities on some wetlands and cover those activities that occur beyond the boundaries of wetlands yet may have an adverse effect on them. State standard-setting for local regulation also is present in many States.

Roughly half of the States without wetland programs listed State influence on Federal actions as their most important means of controlling wetland use. In some cases, State certification of projects through section 401 of CWA and comments on 404 applications are used as substitutes for the creation of State programs that would create political controversies. Requirements for Federal consistency with State coastal-management programs are also an important tool. For example, although South Carolina does not regulate development activities in freshwater wetlands, it does have a policy for their protection in its Coastal Zone Act. Federal actions in the coastal zone, including all 404 permitting, must be consistent with this policy (10).

States may also influence Federal actions (and actions of other State agencies) by developing resource information and preparing management plans and guidelines. For example, the Resource Agency in California prepared the Delta Master Recreation Plan and Waterways Use Program. Although the agency has no direct authority to implement the plan, the management guidelines for natural tidal and nontidal marshes and riparian areas are used by the Corps in administering its permitting programs (4).

A few States listed other State programs not directed specifically toward wetlands as being most important for controlling wetland use. Such programs address water pollution control, endangered species or game species protection, and natural-area acquisition programs. These programs vary greatly in the extent of protection they provide. In some States, one or more of these programs appear to have far-reaching effects on wetland protection. For example, State flood plain regulations may limit construction in large areas of wetlands located in flood plains. However, flood plain regulations in many States do not specifically consider the impact of flood plain development on wetlands. Fill is generally permitted, provided flood elevations are not increased. On the other hand, in New Jersey, the State Flood Hazard Area Control Act is used to protect environmental values in some areas (e.g., trout streams and State wild and scenic rivers) (7).

State acquisition programs targeted at wetlands are present in a few States. However, acquisition may be expensive and can protect only a limited number of wetlands. In addition, acquisition programs have been hit hard by the financial pressures besetting State legislatures. Some States emphasize nonwetlands in their acquisition programs out of preference for upland values because of Federal wetland-acquisition programs in the State (3).

The 20 States with programs specifically directed at wetlands, whether programs stand alone or are subsumed under other programs such as coastal zone management, almost without exception assert that their programs are better than the 404 program in protecting wetlands in the areas covered. However, the OTA study indicated that some State programs may look good on paper but have problems with implementation (3,11). In other cases, a State may have granted the authority to an agency or local government to provide protection to wetlands, but the authority may have not been used (6,7). Case study information also revealed that even where there is regulatory overlap between the State and Federal programs, the 404 program may provide an important regulatory backup for a few projects where the State has neither the authority nor the political will to deny actions that will adversely impact wetlands.

# OVERLAPPING OF STATE/FEDERAL WETLAND REGULATORY PROGRAMS

States differ greatly in the types of wetlands they have, the wetland policies they employ, the problems they experience, and their attitudes toward wetlands and the 404 program. It is difficult therefore to generalize about the relative overlap of State and Federal programs. Tables 25 and 26 illustrate this point for State wetland-regulatory programs in New England. State and Federal programs often overlap or differ in the coverage of activities and areas and procedures used. Some States have nonwetland programs that may indirectly protect wetlands. In those States with strong wetland programs, Corps district offices do not always take an active role in enforcing 404 regulations. Instead, State agencies become the primary parties regulating the use of wetlands, and the Corps usually supports their efforts. Of those States with wetland programs, most believe that State and Federal wetland programs complement one another.

## *Activities and Areas*

Some States regulate more wetland-related *activities* than the Corps does. For example, over 70 percent of the wetlands under the New Jersey Pinelands Preservation Commission's jurisdiction are not subject to Corps individual permit review because flows are less than 5 $ft^3/s$ (7). Many States regulate less area than the Corps but exempt fewer activities from regulation. For example, the North Carolina Dredge and Fill Act does not exempt agricultural or silvicultural activities; however, the law

**Table 25.—Values Protected by State Wetlands Regulatory Progams in New England**

| | Connecticut | | Maine | | Massachusetts | | New Hampshire | | Rhode Island | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Salt | Fresh | Salt | Fresh | Salt | Fresh | Salt | Fresh | Salt | Fresh |
| Flood control | P | P | P | NA | P | P | P | P | P | P |
| Water quality | — | P | — | NA | P | P | — | — | — | — |
| Recreation | P | P | P | NA | — | — | P | P | — | P |
| Fish | P | P | P | NA | P | P | P | P | P | P |
| Wildlife | P | P | P | NA | — | — | P | P | P | P |
| Esthetics | P | P | — | NA | — | — | P | P | P | — |
| Water supply | — | P | P | NA | P | P | — | — | P | P |
| Erosion | P | P | — | NA | — | — | — | — | P | — |
| Sediment capture | P | P | — | NA | — | — | P | P | — | — |
| Shellfish production | P | — | P | NA | P | P | P | P | P | P |
| Navigation | P | — | P | NA | — | — | — | — | — | — |
| Ground water | — | — | — | NA | P | P | P | P | — | P |
| Vegetation | — | — | — | NA | — | — | P | P | P | — |

P = Protected.
— = Not protected.
NA = Not applicable.

SOURCE: Data from OTA's New England case study.

**Table 26.—Exemptions by State Wetland Regulatory Programs in New England**

| | Connecticut | | Maine | | Massachusetts | | New Hampshire | | Rhode Island | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Salt | Fresh | Salt | Fresh | Salt | Fresh | Salt | Fresh | Salt | Fresh |
| Farm ponds | — | • | • | NA | ? | ? | — | — | — | — |
| Farming | — | • | — | NA | • | • | — | — | — | — |
| Boat moorings | — | • | • | NA | — | — | — | — | — | — |
| Municipal water supply | — | • | — | NA | — | — | — | — | — | — |
| Uses incidental to residential property | — | • | — | NA | — | — | — | — | — | — |
| Navigation aids | • | — | — | NA | — | — | — | — | — | — |
| Public health emergencies | • | — | — | NA | — | — | — | — | — | — |
| Mosquito control | • | — | — | NA | • | • | — | — | — | — |
| Snow dumping | — | — | • | NA | — | — | — | — | — | — |
| Maintenance and repair | — | — | • | NA | — | — | • | • | — | — |
| Some requirements for sewage disposal | — | — | • | NA | — | — | — | — | — | — |
| Utility maintenance | — | — | — | NA | • | • | — | — | — | — |
| Emergency work | — | — | — | NA | • | • | — | — | — | — |
| Silviculture | — | — | — | NA | • | • | — | — | — | — |
| Small wetlands (size limits vary by State) | — | — | — | NA | — | — | • | • | — | • |
| Riverbank cut and fill with conditions | — | — | — | NA | — | — | — | — | — | • |

• = Exempted activities.
— = Activities regulated.
NA = Not applicable.

SOURCE: Data from OTA's New England case study.

does not apply to forested wetland species (10). Policies of New Jersey's Hackensack Meadowlands Development Commission are less stringent than the 404 program. For example, the commission allows nonwater-dependent uses of wetlands. It is only because of the 404 program that such projects may be denied or mitigation measures may be required (7). Projects that are smaller than a specified size often are not regulated by State programs, thereby providing convenient loopholes for developers who scale their projects just outside of regulatory control.

In another case, the provisions of the New Jersey Coastal Area Facilities Review Act (CAFRA) generally are similar to section 404 but have some features that are more, or less, stringent. For example, this act prohibits major development in wetlands unless the project is water-dependent, there is no practical alternative on a nonwetland site, or the project involves only minimum alteration of natural tidal circulation, natural contour, or wetland vegetation. This law applies to all activities, not just the disposal of dredged and fill material as does section 404. CAFRA also prohibits development that adversely affects white cedar stands; the 404 program doesn't have such specific prohibitions. However, projects less than a certain size in nontidal marsh wetlands are not regulated under CAFRA, although the Corps might regulate some of these activities (7).

Some State programs have provisions to regulate activities that occur outside of the wetlands but still have some impact on them. The New Jersey Pinelands Preservation Commission program prohibits residential, commercial, and industrial development on wetlands, or within 300 ft of wetlands, unless extraordinary hardship and a demonstrated public need can be shown (7).

State definitions of wetlands and procedures for identifying wetland boundaries may be more restrictive, leaving many wetlands to be regulated only by the Corps. For example, the wetland vegetation list used in Florida is less comprehensive than that of the Corps. Also, the Florida procedure for identifying contiguous wetlands is more restrictive than the Corps'. Any break in the continuity of contiguous, dominant species, even an illegal fill, limits the extent of State jurisdiction (1).

*Wetland values* protected under some State laws are less comprehensive than those of the Corps. For example, Florida restricts its consideration to water-quality impacts under its dredge and fill law (ch. 403), while the Corps considers the broader public interest, including fish and wildlife values (1). Massachusetts wetland permit programs do not consider wildlife values (12).

A few States have more stringent standards for mitigation than does the Corps, requiring developers to provide some sort of compensation or mitigation for all wetlands lost due to development in certain areas—e.g., California and Oregon both have a no-net-wetland-loss standard. California also is committed to increasing wetland acreage by 50 percent by the year 2000 (4).

Broad language in many State laws can be used to provide either strong or weak protection for wetlands. For example, the Nebraska Environmental Protection Act has a pollution prohibition. Water pollution, as defined in the act, could include any human activity affecting wetlands, including wetland drainage due to lowering the water table. The definition of wastes could include fill material disposed of in wetlands. However, these authorities have not yet been used by the State to protect wetlands (6).

In some States, courts have supported broader State authority over development activities that may have implications for wetland protection. For example, the California Supreme Court in 1981 expanded the boundary of the public trust to include the area between the seasonal high and low watermark of all nontidal waters (4). However, in other States, protection for wetlands may be limited by judicial interpretations of past State actions. For example, Florida cannot deny permits to fill submerged lands that were originally sold by the State with the expectation that the area would be developed (11). Other States may lack authority to regulate tidelands that were granted to private landholders prior to statehood (4,10). In Nebraska, agricultural water use is given constitutional preference over all other nondomestic uses. Attempts to reserve water for wetlands may result in constitutional challenges (6).

Some State programs may encourage the protection of wetlands but lack the authority to require protection or mitigation of potential impacts. For example, the California Department of Fish and Game reviews proposals for projects that may alter streambeds and impact fish and wildlife. The department proposes modifications and encourages the applicant to incorporate them into the project. The State does not have the authority to stop any projects (4). The California 1977 Policy for Preservation of Wetlands in Perpetuity also has no direct mechanism for implementation. The policy limits the actions of State agencies in approving projects that will harm wetlands and exempts some wetlands from the policy. However, acre-for-acre compensation still is required (4). In another case, the South Florida Water Management District is authorized to protect water resources and to ensure that construction of surface-water management systems do not adversely affect water resources. The district has authority to designate conservation areas; however, since it can only obtain easements for waterflow, damage to wetlands from development still can occur (1).

## *Implementation Procedures*

The implementation procedures of some State programs ensure better compliance with wetland regulations than do some aspects of the Corps' 404 program. For example, the Mississippi program has a reporting requirement for exempted activities. In addition, exempted activities must be granted an exemption and must still comply with the public purpose of the wetlands law, which is to preserve coastal wetlands except where a higher public interest is served that is consistent with the public trust (2). The Mississippi program also has a mechanism to eliminate unnecessary wetland alteration from activities of State agencies. Four agencies must approve State activities (2).

The State general permit program of the South Florida Water Management District has notification requirements that differ from those of the Corps (1). To obtain a general permit, an applicant must have the project reviewed to ensure that certain standards will be met.

Some States administer programs on a regional level. This practice is thought to provide greater opportunities for monitoring and enforcement, to ensure that decisions are made with a better understanding of local circumstances, to reduce travel time and other costs, and to provide applicants with better access to regulatory personnel (1).

State and Federal procedures for making decisions about wetland use may not be the same, although a similar decision may give the impression that the programs are duplicative. For example, Alaska requirements for oil and gas activities on State lease sale tracts of wet tundra often duplicate requirements on the activities imposed through the 404 program. The State review of operational plans for these activities is conducted by four State agencies. But the review process does not involve the general public or local governments; the 404 review of the same project application may. Critics of the State review process note that the State agency with responsibility for decisions on these operational plans also has primary responsibility for developing State oil and gas resources and for accounting for State revenues (5).

Several Corps districts have been working with State program officials to reduce regulatory overlap and permit processing delays. For example, the Wilmington District's efforts include (10):

- *Joint applications:* the Corps and North Carolina Office of Coastal Management (NCOCM) developed a single permit application for obtaining necessary State and Federal approvals for regulated projects.
- *Joint public notice:* a single public notice was prepared to meet both State and Federal requirements.
- *Joint preapplication meetings and onsite visits:* applicants meet with Federal and State officials to review potential projects. For nonroutine projects, a joint onsite meeting is held prior to the submission of a permit application.
- *Joint postapplication meetings:* when review agencies have objections to a proposed project, the Wilmington District typically will call a meeting to work out the differences between the Federal and State agencies and the applicant. The Corps acts as an arbitrator and has full knowledge of the decisions that are made.
- *Joint enforcement meetings:* since 1972, the Wilmington District and NCOCM have met regularly with other interested Federal and State agencies to discuss policies, regulations, procedures, specific problem permits, and violations.
- *State-program general permit:* perhaps the most far-reaching effort by the Wilmington District and the State of North Carolina to reduce regulatory overlap is the State general permit. This type of permit covered 80 percent of all major projects in 1981. If a permit application qualifies for this general permit, the application is processed by the State, and the Corps and other Federal agencies are given the opportunity to comment. The Corps coor-

dinates the collection of comments of the Federal agencies and determines the Federal conditions that must be included if the State decides to issue the permit. If Federal agencies have objections that cannot be resolved or if they recommend denial, the general-permit processing is terminated, and the application is processed as an individual permit.

# STATE-PROGRAM IMPLEMENTATION PROBLEMS

While a large number of States actively regulate at least some of their wetlands, many face problems that significantly hamper their efforts. These problems are described below in approximate order of importance, according to State responses to the OTA survey. The following discussion should not be taken as characterizing all States, yet all but three States indicated that at least one of the problems was of major concern. Additonal problems that were noted in the case studies also are presented.

## *Funding*

For most of those States with wetland programs, the major implementation problem is inadequate funding for hiring a sufficient number of staff with appropriate expertise and for monitoring and enforcement of permitted activities.* For example, the Florida pay scale is lower than that of the Corps, and there is significant personnel turnover. Also, enforcement budgets at the State level may be inadequate to provide experienced attorneys and expert witnesses. For this reason, Florida often relies on the Corps to pursue enforcement and will settle for after-the-fact permits rather than try to seek penalties and restoration (1).

Difficulties often are related to reduced Federal funding for wetland programs and coastal-zone management activities. Federal assistance has been important to States, for example, in developing inventories, in setting up coastal programs, and in acquiring wetlands. Cutbacks in Federal programs directly affect the capabilities of many States and localities. For example, OCRM is phasing out its grants to States with approved coastal-zone programs. In several cases, funding will be lost for half to all of State staff dealing with coastal wetlands. State acquisition efforts also have been hampered by the elimination of funding from the Land Water Conservation Fund.*

Even more serious than Federal cutbacks is the budgetary crisis confronting many State governments.** Wetland-program budgets generally have not kept pace with inflation, and in most cases, have been static. They have even been projected to decline in the future. Few States have come up with replacements for the Federal funding that will be lost, and few programs, whether dependent on Federal funding or not, are likely to fare well when making funding requests from financially strapped State legislatures. A major factor behind low funding is the absence of legislative and public support for wetland protection, especially when such protection appears to conflict with development activities.

## *General Attitudes Toward Wetlands*

States and regions within States differ radically in the awareness and attitudes of legislators and residents toward wetland values and wetland-protection programs. Unlike coastal wetlands, which in many cases are of great importance to industries such as fishing and tourism, inland wetlands, especially those outside of flyways for waterfowl, have not been as firmly connected in the public mind with functional services and economic benefits. Based on State responses to OTA's questionnaire, lack of support of wetlands programs apparently is due to many factors, including:

---

*Massachusetts, responding to the request on the survey to rank problems in importance, responded "funding, funding, and funding, in that order of priority."

*A few States also have received grants from EPA to study the feasibility of assuming the 404 program. States receiving grants have said that such funding is essential if assumption eventually is to take place.

**Michigan, for example, stated that owing to budget cutbacks, it does not have enough personnel to administer "most effectively" all aspects of the program. Applications for permits are getting processed in a timely fashion, but other important aspects of the program are not being implemented.

- *Lack of awareness of wetland values.* A few States (e.g., Tennessee, West Virginia, Kansas) commented that most residents are unfamiliar with wetland values and are unaware of wetland-protection programs such as 404.
- *Opposition to land use controls.* In some States (e.g., Colorado, Wisconsin, Arkansas, Tennessee), there is strong objection to wetland programs that appear to create de facto land use controls on private property.
- *Sensitivity to regulatory costs and the desire to promote development.* In many States, especially ones in which agriculture is an important industry (e.g., Florida), legislative and public sentiment tends to place a higher priority on development than on wetland preservation when the two goals conflict. Agencies in some States may be forced to bow to political pressure and to allow development that they otherwise would deny or modify.

A few quotes from State responses are indicative of general attitudes:

> Agriculture still remains top priority with Iowa. Wetland alterations are generally accepted by public as well as elected officials.
>
> Iowa

> Any program that was solely designed to protect wetlands is not politically feasible in Wyoming.
>
> Wyoming

> Although the intrinsic values of wetlands are recognized by all State agencies whose functions impinge on wetlands, and a few are strong advocates of wetland protection, the entire question of whether wetlands should be protected or regulated by government has not been addressed by the State (Arkansas) and there is little enthusiasm for doing so now.
>
> Arkansas

To illustrate further, the California Coastal Commission regulates some wetland-alteration activities in the coastal zone where the boundary is subject to political manipulation. The California Legislature has changed the boundary several times (4). The only statewide protection given to wetlands is provided indirectly through water-quality authorities who require permits for the discharge of pollutants into State waters. However, the effect of discharges upon wetlands usually is not a separate consideration in the permit process, which focuses on water quality, especially the quality of water used by people. Wetland habitat values are rarely considered.

## *Monitoring and Enforcement*

Monitoring and enforcement was mentioned as a problem by 14 States and was ranked first in importance by 3; other sources also have concluded that this is a serious problem for many States. Some States undertake site inspections for all permitted development activities at least once during construction and after project completion. In other States, monitoring is less comprehensive. Inland wetlands are particularly neglected (9).

States experience even greater difficulties with enforcement. According to one source, agencies seeking administrative action in case of violations are limited in some States to seeking injunctions or issuing temporary cease-and-desist orders, with the assistance of State or local prosecutors. Agencies in such cases do not have the power to impose fines or criminal citations; where penalties are available, they may be too low to constitute effective deterrents (9). It is also sometimes difficult to get State attorneys general to prosecute wetland violators. Some States turn prosecution over to local authorities, who are often subject to political pressure. At both State and local levels, prosecutors are reluctant to prosecute small violations and even in cases of large violations have more pressing priorities than wetland cases. Although compliance with some State laws generally may be good, some States have difficulty in obtaining restoration for those illegal fills that do take place (11).

## *Inadequate Technical Information and Expertise*

A major problem hampering many States is the lack of information regarding the wetland resources of their area. Most States have little data on such things as the location, size, vegetation types, and wildlife habitat values of wetland areas covered under State programs. Some States say they have insufficient technical expertise to determine wetland boundaries and values and insufficient funds to hire additional staff. Many States expressed the hope that the Fish and Wildlife Service (FWS) inventory effort will be accelerated and that increased aid be given to States for their own inventories.

### *Agency Fragmentation*

In many States, more than one agency handles programs that protect wetlands. In some States, there may be four or more agencies involved. Inconsistency in policy often results. Another sort of fragmentation takes place within single agencies: agencies and their personnel with wetland-protection responsibilities often have other duties as well. Divided responsibilities between State and local governments also can cause problems for wetland protection. For example, the North Dakota Drainage Law is implemented at the State and local level. Complaints about illegal drains are reported to the State, but the local water board is responsible for forcing closure. The J. Clark Salyer National Wildlife Refuge requested closure of over 200 illegal private drains in 1978. The State Water Commission informed the local boards and sent 200 violation letters. None of these drains had been closed as of August 1982 (3).

### *State Interest in Assuming 404 Permitting*

Somewhat less than a third of the 48 States responding to OTA's survey are interested in the possibility of assuming responsibility for a portion of the 404 program. Through such assumption, some States hope to get a stronger regulatory program; some a weaker program. However, almost none of these States is willing to assume the program without major changes in one or more of the following: current EPA regulations governing assumption, the scope of areas that States would be allowed to administer, and, most importantly, financial assistance. In fact, only four States have accepted responsibility for 404 permitting on an experimental basis. If the Federal Government reduced its involvement in wetland protection, wetlands would receive mixed levels of protection from the States, owing to States' budgetary and political constraints. In response to cutbacks in the 404 program, few States would be willing at this time to increase the current level of wetland protection without additional resources from the Federal Government; even with resources some States would be reluctant.

## CHAPTER 9 REFERENCES

1. Center for Governmental Responsibility, "Wetlands Loss in South Florida and the Implementation of Section 404 of the Clean Water Act," University of Florida College of Law, contract study for OTA, September 1982, pp. 58-61.
2. Center for Wetland Resources, "Wetland Trends and Factors Influencing Wetland Use in the Area Influenced by the Lower Mississippi River: A Case Study," Louisiana State University, contract study for OTA, September 1982, pp. II20-II23.
3. Department of Agricultural Economics, "Wetlands in the Prairie-Pothole Region of Minnesota, North Dakota, and South Dakota—Trends and Issues," North Dakota State University, contract study for OTA, August 1982, p. 73.
4. ESA/Madrone, "Wetlands Policy Assessment: California Case Study," contract study for OTA, September 1982, pp. 19-63.
5. ESA/Madrone, "Wetlands Use and Regulation: Alaska Case Study," contract study for OTA, January 1983, p. vi.
6. Great Plains Office of Policy Studies, "Wetlands Trends and Protection Programs in Nebraska," University of Nebraska, contract study for OTA, September 1982, p. 49,
7. JACA Corp., "A Case Study of New Jersey Wetlands Trends and Factors Influencing Wetlands Use," contract study for OTA, September 1982, pp. 3-23, 34.
8. Kusler, Jon, "Strengthening State Wetland Regulations," Fish and Wildlife Service, 1978, pp. 25-28.
9. Rosenbaum, Nelson, "Enforcing Wetlands Regulations," in *Wetland Functions and Values: The State of Our Understanding,* American Water Resources Association, 1979, pp. 43-49.
10. School of Forestry and Environmental Studies,

"Wetland Trends and Policies in North and South Carolina," Duke University, contract study for OTA, August 1982, pp. 63, 87-89.

11. Shapiro and Associates, Inc., "An Analysis of Wetlands Regulation and the Corps of Engineers Section 404 Program in Western Washington," contract study for OTA, September 1982, pp. 3, 41.
12. Water Resources Research Center, "Regional Assessment of Wetlands Regulation Programs in New England," University of Massachusetts, contract study for OTA, September 1982, p. 144.

## Appendix

# List of Acronyms and Glossary

## Appendix

# List of Acronyms and Glossary

## *List of Acronyms*

AAPA — American Association of Port Authorities
ACP — Agricultural Conservation Program
AMC — American Mining Congress
API — American Petroleum Institute
API/NFPA — American Paper Institute/National Forest Products Association
AWO — American Waterways Operators, Inc.
BMPs — best management practices
CEQ — Council on Environmental Quality
Corps — U.S. Army Corps of Engineers
CPI — Consumer Price Index
CWA — Clean Water Act
CZM — Coastal Zone Management
EIS — Environmental Impact Statement
EPA — Environmental Protection Agency
FI — Fertilizer Institute
FmHA — Farmers Home Administration
FWS — Fish and Wildlife Service
GNP — gross national product
IWR — Institute for Water Resources
LWCF — Land and Water Conservation Fund Act
MOA — memorandum of agreement
NCA — normal crop average
NEPA — National Environmental Policy Act
NFIP — National Flood Insurance Program
NMFS — National Marine Fisheries Service
NPDES — National Pollution Discharge Elimination System
NSF — National Science Foundation
NWTS — National Wetlands Trend Study
OCRM — Office of Ocean and Coastal Resource Management
OCZM — Office of Coastal Zone Management
OMB — Office of Management and Budget
ORD — Office of Research and Development (EPA)
OTA — Office of Technology Assessment
PIK — Payment-in-Kind Program
POWDR — Protect Our Wetlands and Duck Resources Act
RIA — regulatory impact assessment
SCS — Soil Conservation Service
USDA — U.S. Department of Agriculture
WES — Waterways Experiment Station

## *Glossary*

**Acquisition**—the purchase of the full rights to a property.

**Alluvium**—soil composed primarily of eroded material, such as sand, silt or clay, that has been deposited on land by rivers and streams overflowing their banks.

**Barrier island**—a detached portion of a barrier bar, usually formed through wave deposits, lying offshore, and usually parallel to the shore whose crest rises above high water.

**Biochemical oxygen demand (BOD)**—the demand for dissolved oxygen needed for the decomposition of organic matter in water. If the amount of oxygen dissolved in water is high and the organic matter present is low, the BOD is low, and vice versa.

**Biomass**—the total amount of organic material present during a specific instance in a community or in a particular population or other component of the community.

**Bog**—a term commonly applied to forested wetlands formed in deep, steep-sided lakes with small watershed areas and poor drainage. Decomposition rates are characteristically slow, resulting in extensive deposits of peat. Floating mats of Sphagnum moss are commonly associated with bogs.

**Bottom land**—flat-lying areas adjacent to rivers, which are subject to annual flooding.

**Brackish**—a mixture of freshwater and saltwater typically found in estuarine areas.

**Bulkhead**—a structure usually running parallel to the shoreline of a river, stream, or lake to protect adjacent lands from erosion due to current or wave action, and to protect channels from upland sedimentation.

**Conditioning (permit)**—requirements attached to a permit that dictate the mitigation of or compensation for development project impacts.

**Cumulative impacts**—those impacts on the environment that result from the incremental impact of a development activity when added to other past, present, and reasonably foreseeable future activities.

**Deciduous**—a descriptive term for woody plants that shed their green leaves or needles during the cold or dry season.

**Detritus**—a partially decomposed organic material produced by the disintegration and decay of plant tissues, principally leaves and stems.

**Dike**—a wall or mound built around a low-lying area to prevent flooding.

**Drainage basin or watershed**—the area within which all surface water runoff will normally gather in a single tributary, stream, river, conduit, or other water course. This area is determined by topography that forms drainage divides between watersheds.

**Ecosystem**—the system of interrelationships between plants and animals and their environment.

**Emergent**—an erect, rooted herbaceous hydrophyte that may be temporarily or permanently flooded at the base, but is nearly always exposed at the upper portion.

**Endangered**—nearing extinction; existence of the organism and its environment are in immediate jeopardy; distribution is usually restricted to highly specific habitats.

**Estuary**—the mouth of a river entering the sea where the current of the river meets the tide and where salt and fresh waters mix.

**Eutrophication**—an increase in concentration of nutrients in rivers, estuaries, and other bodies of water. This increase may be due to natural causes, man's influence, or a combination of both.

**Evergreen**—a descriptive term for woody plants that retain their green leaves or needles throughout the year.

**Flood hydrographs**—graphs of the time distribution of runoff from a drainage basin which are used to analyze flooding characteristics.

**Flood plain**—an area adjacent to a lake, stream, ocean, or other body of water lying outside of the ordinary banks of the water body and periodically inundated by flood flows.

**Flyways**—routes followed by migrating birds.

**Food chain**—the means by which energy and material are transferred from a producer (a green plant) to herbivores and carnivores.

**General permit**—a type of permit that is issued for a category or categories of work or structures when those structures or work are substantially similar in nature and cause only minimal individual and cumulative adverse environmental impacts.

**Glacial drift**—sediment accumulated as a result of glaciation, under a glacier, at its margins, or beyond.

**Ground water**—water that penetrates the Earth's surface from precipitation and from infiltration by streams, ponds, and lakes.

**Habitat**—the range of environmental factors at a particular location supporting specific plant and animal communities.

**Herbaceous**—plant material characterized by the absence of wood.

**Hydrophyte**—any plant growing in a soil that is at least periodically deficient in oxygen as a result of excessive water content.

**Indirect impacts**—impacts removed from both the direct area and time that development occurs.

**Mangrove**—a term denoting any salt-tolerant intertidal tree species.

**Marsh**—a common term applied to describe treeless wetlands characterized by shallow water and abundant emergent, floating, and submergent wetland flora. Typically found in shallow basins, on lake margins, along low-gradient rivers and in low-energy tidal areas.

**Mitigation**—a term that describes the efforts to lessen, or compensate for the impacts of a development project.

**Mudflat**—bare, flat bottoms of lakes, rivers, and estuaries, which are largely filled with organic deposits, and periodically exposed by a lowering of the water table.

**Nationwide permit**—A type of general permit authorized for the entire Nation.

**Organic soil**—a "histosol" as defined by the U.S. Soil Conservation Service. In general, a soil is a histosol either if more than 50 percent of the upper 80 cm of soil is organic material or if organic material of any thickness rests on rock or on fragmented material having interstices filled with organic materials.

**Peat**—organic soil which has undergone very little decomposition so that plant remains can be identified.

**Permeability**—the property of soil or rock to transmit water or air.

**Productivity, gross primary**—the rate at which energy is fixed by a particular population or community of producers.

**Productivity, net primary**—the rate of increase in the energy that is contained in a particular population or community of producers after the amount of energy that is lost by respiration is deducted from the gross productivity.

**Recharge (ground water)**—the percolation of surface water to the water table.

**Riparian**—habitats adjacent to rivers and streams.

**Riprap**—a bulkhead or other structure constructed of selected rock or concrete and placed so as to dissipate wave energy or collect sand along a shoreline.

**Sedge**—a grasslike plant in appearance, of the family cyperaceae, often with a triangular base.

**Shrub**—a woody plant that at maturity is less than 6 meters tall, usually exhibiting several erect, spreading, or prostrate stems and a generally bushy appearance.

**Slough**—a small body of stagnant water, or a small marshy or swampy tract of land.

**Submergent**—a herbaceous or nonvascular plant, either rooted or nonrooted, which lies entirely beneath the water surface, except for flowering parts in some species.

**Substrate**—the bottom surface on which plants grow.

**Swamp**—a forested wetland.

**Threatened**—nearing endangered status.

**Tundra**—a wet arctic grassland dominated by lichens and Sphagnum mosses. It is characterized by a thick spongy mat of living and undecayed vegetation that is often saturated with water.

**Turbidity**—the cloudy condition of a body of water that contains suspended material, such as clay or silt particles, dead organisms, or small living plants or animals.

**Watershed**—the region drained by or contributing water to a stream, lake, or other body of water.

**Water table**—the upper surface of ground water in the zone of saturation.

# Index

# Index

Adirondack-New England, 96
Agassiz National Wildlife Refuge, 45
Agricultural Conservation Program (ACP), 77, 79
Alaska, 3, 16, 19, 25, 30, 52, 72, 87, 88, 99, 127, 132, 148, 152, 157, 192
Alcovy River Swamp, Ga., 42
American Association of Port Authorities (AAPA), 154
American Mining Congress (AMC), 155
American Paper Institute/National Forest Products Association, 152, 154, 155
American Petroleum Institute (API), 155, 159
American Waterways Operators, Inc., 154
Anchorage (Alaska) Wetland Plan, 19
Arkansas, 78, 194
Atlantic City, N.J., 127
Audubon Society, 13, 84
*Avoyelle's Sportsmen's League* v. *Alexander,* 176

Bass Angler's Sportsmen Society, 84
best management practices (BMPs), 132, 143, 170
Blackstone River, Mass., 45
Bombay Hook National Wildlife Refuge, Del., 41
Bureau of Reclamation, 74

Cache River, Ill., 5, 44
California, 8, 52, 73, 99, 108, 111, 120, 123, 170, 172, 188, 191, 194
California Supreme Court, 191
Canada, 52
capabilities of States, 187-195
  implementation problems, 193-195
    agency fragmentation, 195
    funding, 193
    inadequate technical information and expertise, 194
    interest in assuming 404 permitting, 195
    general attitudes, 193
    monitoring and enforcement, 194
  State and Federal regulatory programs, overlapping of, 189-193
    activities and areas, 189
    implementation procedures, 192
Carter, President Jimmy, 38, 78
Cedarburg Bog, Milwaukee, Wis., 47
Charles River Basin, Mass., 4, 37, 45
Chesapeake Bay, 47, 52, 60, 124
Coastal Zone Management program, 75, 83
Congress:
  House Committee on Merchant Marine and Fisheries, 167
Connecticut, 84
Corkscrew Swamp Sanctuary, Fla., 41
Council on Environmental Quality (CEQ), 118, 129
Cranesville Swamp, W. Va., 40
Currituck Sound, N.C., 48

Delaware, 41
Department of Agriculture (USDA), 12, 90
  Agriculture Stabilization and Conservation Service (ASCS), 73, 77, 78, 112
  Farmers Home Administration, 77, 80
  Payment-in-Kind Program (PIK), 9, 15
  Secretary of, 73
  Soil Conservation Service (SCS), 73, 74, 77, 78, 80, 90, 91, 148, 171
  Water Bank Program, 9, 12, 15, 19, 20, 73
Department of Commerce:
  Office of Ocean and Coastal Resource Management, 187
  Secretary of, 83
Department of the Interior, 13, 69
  Secretary of, 77, 84
Department of Justice, 180, 181
District of Columbia, 72
Ducks Unlimited, 13, 84

East Everglades Management Plan, 134
effects of the 404 program, 141-161
  delay costs, 156
    length of delays, 157
    percentage of permits delayed, 156
    sources of delay, 157
  distribution of costs, 160
  effects on wetlands, 141-145
    benefits of the 404 program to regulated sectors, 146
    effects on development activities, 145
    general objections by regulated sectors, 147
      congressional intent, 149
      program administration, 151
    program effects not reflected in permit data, 142
    program effects reflected in program data, 143
    specific impacts, 152
  modifications costs, 155
  opportunity costs, 159
  processing costs, 154
Environmental Impact Statement (EIS), 11, 141, 154, 171
Environmental Law Institute, 77
Environmental Protection Agency (EPA), 10, 13, 17, 18, 70, 71, 75, 76, 133, 135, 155, 158, 167, 169, 187
  Office of Research and Development (ORD), 77
Everglades National Park, Fla., 42
Executive Order 11988, Flood Plain Management, 74
Executive Order 11990, Protection of Wetlands, 17, 74, 78, 80, 171

Farmers Home Administration, 12
Federal Crop Insurance Agency, 80
Federal Emergency Management Agency, 76
Federal Office of Coastal Zone Management, 75
Federal programs, 69-81
  acquisition and incentive programs, 72
  Agriculture Conservation Program, 77
  agricultural conversions, 77
    Federal tax, 78
  assistance to States and localities, 75

  - environmental programs and policies, 74
  - regulatory permitting programs, 69
  - wetland research program, 76
- *Federal Register*, 174
- Fertilizer Institute, 146, 152, 159
- Florida, 31, 41, 42, 60, 87, 97, 99, 108, 111, 119, 120, 122, 130, 152, 168, 188, 191, 192

- General Accounting Office (GAO), 132, 133, 156, 157
- geographic distribution of wetland types, 32
- Georgia, 25, 41, 42
- Gianelli, William R., Assistant Secretary of the Army (Civil Works), 167
- Grays Harbor (Washington) Estuary Management Plan, 134
- Great Plains Program, 79
- Great Swamp Refuge, N.Y., 42

- Hackensack River, N.J., 47
- Hammond, Edwin H., 29
- Hawaii, 87
- Hilton Head Island, S.C., 124
- hydrologic characteristics of wetlands, 28

- Illinois, 51, 94
- impacts and mitigation, 117-135
  - definitions, 118
  - development activities, 119-124
    - disposal and discharge of pollutants and nonpoint-source pollution, 123
    - drainage and clearing, 121
    - dredging and excavation, 119
    - extensive flooding, 122
    - filling, 120
    - predicting impacts of, 126
      - general permits, 128
      - limitations, 126
      - wetland reviews, 127
    - water withdrawals and diversions, 123
  - mitigating impacts, 129
    - feasibility of compensation on offsite mitigation, 130
    - management plans, 133
    - onsite mitigation to minimize impacts, 131
  - variables of wetland-impact magnitude, 124
    - biological and ecological variables, 125
    - operations variables, 125
    - physical and chemical variables, 124
- importance of wetlands to man, 37-61
  - attitudes, 37
  - ecological services, 43-61
    - climatic and atmospheric functions, 60
    - fish and wildlife values, 52-61
      - endangered wetland species, 57
      - pattern of duck distribution, 53
    - floodpeak reduction, 43-46
    - ground water recharge, 47
    - shoreline erosion control, 46-47
    - water quality improvement, 48-51
  - intrinsic values, 39, 42
    - recreation and education, 41
    - wetlands or natural areas, 39
- Indiana, 27
- Iowa, 97, 194
- Ipswich River, Mass., 45

- J. Clark Salyer National Wildlife Refuge, 195
- J. N. Ding Darling Refuge, Fla., 42

- Kearneysville, W. Va., 77
- Kentucky, 27
- Kissimmee River, 51

- Lake Okeechobee, Fla., 51
- Land and Water Conservation Fund, 76
- Lawrence Swamp, Mass., 47, 48
- legislation:
  - California Coastal Act, 131
  - Clean Water Act (CWA), 4, 9, 10, 15, 69, 70, 75, 82, 187
    - 404 program, 10, 14, 15, 16, 17, 69, 70, 134, 141-161, 167-182
  - Coastal and Inland Wetland Restriction Act, 81
  - Coastal Zone Management Act, 9, 75, 83, 188
  - Dingell-Johnson Act, 75
  - Endangered Species Act, 74
  - Federal Aid in Fish Restoration Act, 75
  - Federal Aid to Wildlife Restoration Act, 9, 75
  - Federal Water Pollution Control Act (FWPCA), 69, 149
  - Fish and Wildlife Coordination Act, 74, 83
  - Land and Water Conservation Fund Act of 1965, 12, 73
  - National Environmental Policy Act (NEPA), 11, 75, 118, 141, 154, 171
  - Nebraska Environmental Protection Act, 191
  - Nebraska Groundwater Management Act of 1975, 188
  - New Jersey Coastal Area Facilities Review Act, 190
  - New Jersey Flood Hazard Area Control Act, 189
  - North Carolina Coastal Area Management Act, 173
  - North Carolina Dredge and Fill Act, 189
  - North Dakota Drainage Law, 195
  - Pittman-Robertson Act, 75
  - Protect Our Wetlands and Duck Resources Act (POWDR), 13, 69, 84
  - Rivers and Harbors Act of 1899, 10, 11, 72
  - Swamp Land Acts, 37
  - Water Bank Act of 1970, 12
  - Wetlands Loan Act, 9, 12, 13, 69, 72
- limitations of the 404 program, 167-182
  - Corps performance, 175-182
    - district implementation, 176
    - monitoring and enforcement, 177
    - regulatory policies, 175
  - scope of coverage, 168-174
    - cumulative impacts, 174
    - decisionmaking criteria, 174
    - exempted activities, 170
    - general permits, 173
    - nationwide permits, 171
    - unregulated activities, 168

local programs, 83
Louisiana, 55, 89, 97, 99, 113, 119, 122, 131, 159
  Western Judicial District, 176
Lower Mississippi Alluvial Plain, 89, 95, 97, 148
Lower Mississippi River Valley, 5, 7, 56, 87, 99, 108, 113, 120
Loxahatchee Refuge, Fla., 42

Maine, 25
major types of wetlands, 29
  bogs, 30
  bottom lands and other riparian habitats, 30
  coastal salt marshes, 31
  inland freshwater marshes, 29
  inland saline marshes, 30
  mangrove swamps, 31
  shrub swamp, 30
  tidal freshwater marshes, 32
  tundra, 30
  wooded swamps, 30
Maryland, 55, 99, 119, 146
Massachusetts, 26, 39, 45, 81, 84, 89, 146
Merritt Island National Wildlife Refuge, Fla., 41
Michigan, 13, 25, 119
Migratory Bird Conservation Fund, 69
Migratory Bird Hunting and Conservation Stamps, 9, 12, 72
Minnesota, 25, 47, 73, 77, 79, 80, 95, 98, 112, 119, 180
  Protected Waters Program, 81
  Water Bank Program, 82
Mississippi, 119, 192
Mississippi Delta, 26
Mississippi River, 26, 52, 80, 89, 130
Muskie, Senator Edmund, 170

National Flood Insurance Program (NFIP), 76, 84
National Forest Service, 72
National Forest System, 72
National Marine Fisheries Service (NMFS), 10, 11, 18, 70, 71, 74, 76, 77, 83, 141, 142, 144, 145, 158, 167, 178
National Park Service, 73
National Pollution Discharge Elimination System, 75
National Science Foundation (NSF), 76, 77
National Wetland Trends Study (NWTS), 87, 88, 89, 90, 91, 94, 98, 108, 170, 171
National Wildlife Refuge System, 16, 41, 52, 72, 73
*Natural Resources Defense Council, Inc.* v. *Callaway*, 10, 70
Nature Conservancy, 13, 43, 84, 181
Nebraska, 27, 79, 80, 88, 97, 99, 109, 112, 120, 169, 180, 188
Neponset River Basin, Mass., 45
New Jersey, 99, 146, 173, 189, 190, 191
New York, 25, 42, 174
North Carolina, 5, 40, 43, 55, 99, 109, 119, 152, 168, 173, 180
North Carolina Office of Coastal Management, 192
North Dakota, 25, 73, 77, 112, 180

Office of Coastal Zone Management (OCZM), 134
Office of Management and Budget (OMB), 146, 155, 156, 157, 177
Okefenokee Swamp, Ga., 41, 42
Oregon, 55
origins of wetlands, 25-28
  activities of man, 27
  beaver dams, 26
  distribution of wetlands in the United States, 26
  erosion and sedimentation, 25
  freezing and thawing, 26
  glaciation, 25
  miscellaneous processes, 27

Passaic River, N.J., 45
Pennsylvania, 41, 42
Platte River Valley, Nebr., 169
policy considerations and options, 13-21
  issues and options, 14-21
private initiatives, 84
programs and policies affecting wetland use, 8-13
  administration policies, 13
  Federal programs discouraging wetland conversion, 10
  Federal programs encouraging wetland conversions, 12
  Federal regulation—404 program, 10-12
  major Federal programs, 9
  private initiatives, 13
  State wetland programs, 13

Rainwater Basin, Nebr., 79, 80, 109, 112, 120, 169
Reelfoot Lake, Tenn., 28
Richard King Mellon Foundation, 13, 84
Reilly, William, 39

Sacramento-San Joaquin Valley, Calif., 122
San Diego County, Calif., 172
San Francisco Bay, 6, 28, 117, 130
Snohomish Estuary Wetland Study, Seattle district, 127
South Carolina, 99, 168, 178, 188
South Carolina Heritage Trust Program, 43
South Dakota, 73, 77
State programs, 81-83
  acquisition, 82
  incentives to landowners, 82
  influence on Federal activities, 82
  wetland regulation, 81

tax incentives, 12, 15
Tennessee, 28
Texas, 55, 99, 119, 130
Thief Run Wildlife Management Area, 45
Thompson, Edward, Jr., 170
Tinicum Marsh, Pa., 41, 42

U.S. Army Corps of Engineers, 3, 4, 10, 11, 12, 13, 14, 15, 16, 17, 18, 37, 69, 70, 76, 82, 110, 126, 128, 129, 141, 143, 156, 174, 175-182
  Assistant Secretary of the Army (Civil Works), 71, 157, 167

Institute for Water Resources, 142, 147, 153, 154, 155, 156, 159, 160
U.S. Fish and Wildlife Service (FWS), 10, 12, 18, 19, 25, 38, 56, 70, 71, 74, 75, 76, 83, 84, 87, 90, 112, 134, 158, 167, 195

values and uses, 4-8
  intrinsic qualities and ecological services, 4, 5
  trends in wetland use, 7
  wetland conversions, 5
Virginia, 46, 84

Washington, 25, 55, 99, 108, 178
Waterways Experiment Station (WES), 76
Wharton, C. H., 42
Watt, James, Secretary of Interior, 84
West Virginia, 40
wetland trends, 87-113
  national trends—loss and gain, 87-91, 112
    factors affecting wetland loss, 88
    trend information, 90
  vegetated wetlands, 91
    agricultural conversions, 108
      economic factors, 111
    freshwater wetlands, 91
    regional trends, 94
      agricultural conversions of wetlands, 100
      case studies, 98
      wetland losses, 106
    saltwater wetlands, 93
wetland vegetation, 28
Wisconsin, 25, 51, 56, 78, 83, 94, 130
Wisconsin scientific areas program, 43
Wyoming, 194

## Office of Technology Assessment

The Office of Technology Assessment (OTA) was created in 1972 as an analytical arm of Congress. OTA's basic function is to help legislative policymakers anticipate and plan for the consequences of technological changes and to examine the many ways, expected and unexpected, in which technology affects people's lives. The assessment of technology calls for exploration of the physical, biological, economic, social, and political impacts that can result from applications of scientific knowledge. OTA provides Congress with independent and timely information about the potential effects—both beneficial and harmful—of technological applications.

Requests for studies are made by chairmen of standing committees of the House of Representatives or Senate; by the Technology Assessment Board, the governing body of OTA; or by the Director of OTA in consultation with the Board.

The Technology Assessment Board is composed of six members of the House, six members of the Senate, and the OTA Director, who is a nonvoting member.

OTA has studies under way in nine program areas: energy and materials; industry, technology, and employment; international security and commerce; biological applications; food and renewable resources; health; communication and information technologies; oceans and environment; and science, transportation, and innovation.

OTA-O-206

MARCH 1984